AUTOMOBILE ENGINEER

NOVEMBER 1961

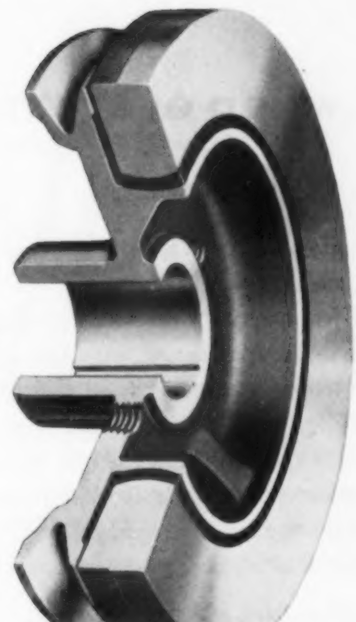
Three Shillings & Sixpence


An Arsenal of Engineering Machinery
INCLUDING
Power presses up to 500 tons. Stretch forming presses. "Cecostamp" drop hammers. Welding—seam, stitch, spot, argon etc.
An Army of Skilled Engineers
INCLUDING
Craftsmen in sheet metal manipulation, skilled tool makers and fully approved inspection staffs.
AMONG OUR MANY ESTEEMED CUSTOMERS
Bristol Siddeley Engines Ltd.
Carbodies Ltd.
Daimler Company Ltd.
The David Brown Companies.
Ford Motor Company Ltd.
Jaguar Cars Ltd.
John Curran Limited
The Plessey Company Ltd.
Rover Company Ltd.
A.I.D.
A.R.B. and
C.I.A.
APPROVED
& a Chest Full of Medals for jobs well done
FOR DESIGN PROTOTYPE & PRODUCTION WORK, CONTACT—
We Shape the things to come!
The Abbey Panel & Sheet Metal Co. Ltd.
BAYTON ROAD, EXHALL, NR. COVENTRY. TEL: BEDWORTH 2071 (P.B.X)

chosen by
B.M.C. & VAUXHALL

HOLSET

NON–BONDED CRANKSHAFT DAMPERS



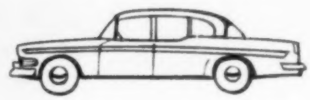
The Holset Non-bonded Crankshaft Damper is a combined torsional vibration damper and pulley ready balanced and assembled for fitting to the engine.

A Member of the B.H.D. Engineers Limited Group of Companies.

THE HOLSET ENGINEERING CO. LTD.

TURNBRIDGE, HUDDERSFIELD. TELEPHONE: HUDDERSFIELD 7430 TELEGRAMS: HOLSET, HUDDERSFIELD — TELEX

...at HUMBER LTD.



EFCO and ROOTES craftsmanship

With the constant demands for more productivity, is it inevitable that quality must be sacrificed to expediency? Fortunately for discriminating buyers, Humber say 'No' and support their view by installing batteries of Efco heat treatment furnaces to help increase their output *without* detriment to ROOTES Craftsmanship.

Used for processing gearbox components, crown wheels and pinions, these furnaces are the practical end-product of the most up-to-date design thinking. The furnaces all have automatic handling and programming equipment to speed production and cut operating costs. Furnaces for gears have an enclosed hot-oil quench to ensure close dimensional control. Furnaces for crown wheels have special holding chambers to give precise control of cooling and carbon diffusion cycles prior to press quenching.

Humber Cars have a reputation for quality. EFCO furnaces are helping to maintain that reputation.

EFCO FURNACES LIMITED

QUEENS ROAD, WEYBRIDGE, SURREY · *Weybridge 3891*

Associated with Electro-Chemical Engineering Co. Ltd.

NRP/1/4150


LOCKHEED
A new range of disc brakes for all types of cars from the smallest to the largest, giving increased disc diameter within a given wheel and excellent access for bleeding.
Also a completely new range of drum brakes.
LOCKHEED HYDRAULIC BRAKE COMPANY LIMITED
LEAMINGTON SPA
Regd. Trade Mark LOCKHEED
IMPORTANT COMPONENTS AT
THE AUTOMOTIVE
AUTOMOTIVE PRODUCTS ASSOCIATED
The new Purolator 'Panelair' air filter—compact to match low bonnet lines—efficient to meet modern standards of durability. Easy to maintain, quick-to-replace element. Unit design adaptable to suit any through-flow and space available.
AUTOMOTIVE PRODUCTS COMPANY LIMITED
LEAMINGTON SPA
PUROLATOR

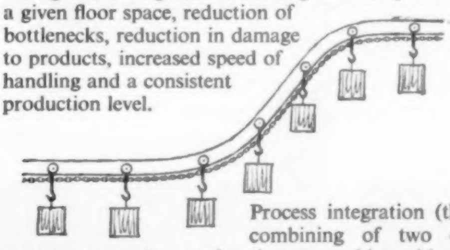

BORG & BECK
Three ranges of clutches for every type of motor car: the well proved 'A' Type from 6¼" to 10" diameter; the 8/8½" A.S. type strap drive clutch; the D/S Type clutches with the new diaphragm spring. Driven plates with spring centre and release bearings, to suit each clutch.
BORG & BECK COMPANY LIMITED
THE MOTOR SHOW BY MEMBERS OF
PRODUCTS GROUP
LTD., LEAMINGTON SPA. ENGLAND
Self-adjusting steering and suspension joints. Available also as self-lubricating types with moulded bearings, obviating the need for maintenance.
AUTOMOTIVE PRODUCTS COMPANY LIMITED
THOMPSON

Materials Handling-1

Materials handling may well be defined as the technology covering the movement and storage of everything in and about industrial or commercial premises. The term covers the handling of raw materials as well as tools; the movement of components between operations and in stores, of finished products, and of the scrap, cutting oils and process machinery; and the movement of workpeople in relation to the handling of material.

The object of a materials-handling survey is to eliminate handling as far as possible and to study the remaining operations to ascertain if they can be economically and efficiently mechanised, i.e., if mechanical handling can be applied.

Improved materials handling raises productivity, for it gives, among other benefits: greater output from a given floor space, reduction of bottlenecks, reduction in damage to products, increased speed of handling and a consistent production level.



Process integration (the combining of two or more processes in one situation or machine with no manual inter-process handling, or the mechanical linking together of two or more processes for automatic operation) is one of the preliminary steps in the development of automation. A stage is achieved quite close to automation when the processing and handling are completely integrated, for then instrumentation and control can be readily applied.

MECHANICAL HANDLING

Many kinds of mechanical-handling equipment are in use today, each with its own attributes and uses, but in most cases there is only one type which offers the best solution to any one handling problem. Most mechanical-handling equipment is electrically operated, and the judicious use of electricity in this way can substantially increase productivity, reduce production costs and improve conditions for the worker, for the expenditure of very little power.

Main Categories of Mechanical Handling Equipment

LIFTING EQUIPMENT; OVERHEAD RUNWAYS; CRANES; CONVEYORS AND ELEVATORS; INDUSTRIAL TRUCKS.

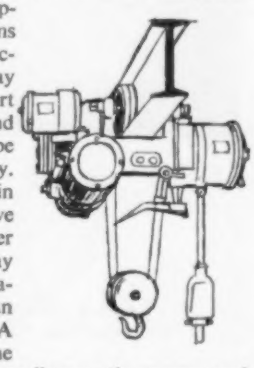
LIFTING EQUIPMENT

Electric pulley blocks are used for loading and unloading purposes, warehousing and in process work. When used with a trolley they have great flexibility. No manual effort is required, hence lifting does not cause any fatigue. They may use either chain or wire rope, and the speed of lift of both types is slower as the lifting capacity increases. An inching motor may be fitted to give a very slow speed for accurately positioning the load, for example in a jig.

Lifting magnets are used for the handling of iron and steel in conjunction with a crane or hoist. They do away with the necessity for slings and give increased speed of movement. They can lift castings, ingots and swarf, scrap, rolled steel sections, and can be used in loading bays, yards, machine shops, foundries and steelworks.

OVERHEAD RUNWAYS

Overhead runways have many uses where lifting and/or transport are required, when frequency of flow does not warrant a conveyor, e.g., for loading and unloading lorries, in core ovens, for feeding machines, for storage, for maintenance purposes, for textile drying and interconnecting two or more buildings. A runway consists of a steel girder along which a load trolley runs, and can incorporate switches, turntables, drop-sections and drop-arms and weigh-sections. Electrification of a runway takes all the manual effort out of the handling and movement, which can be completed more quickly. It consists of two main items: the electrified drive of the trolley (i.e., a power trolley) along the runway and an electrically operated lifting unit, usually an electric pulley block. A telpher has a cab for the operator suspended from trolleys on the runway and mechanically connected to the electrically driven trolley of the pulley blocks, thus travelling with them. Telphers are employed for handling individual loads which may be outside the range of normal electric blocks, e.g., when the highest speeds of travel or hoisting are required.



For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

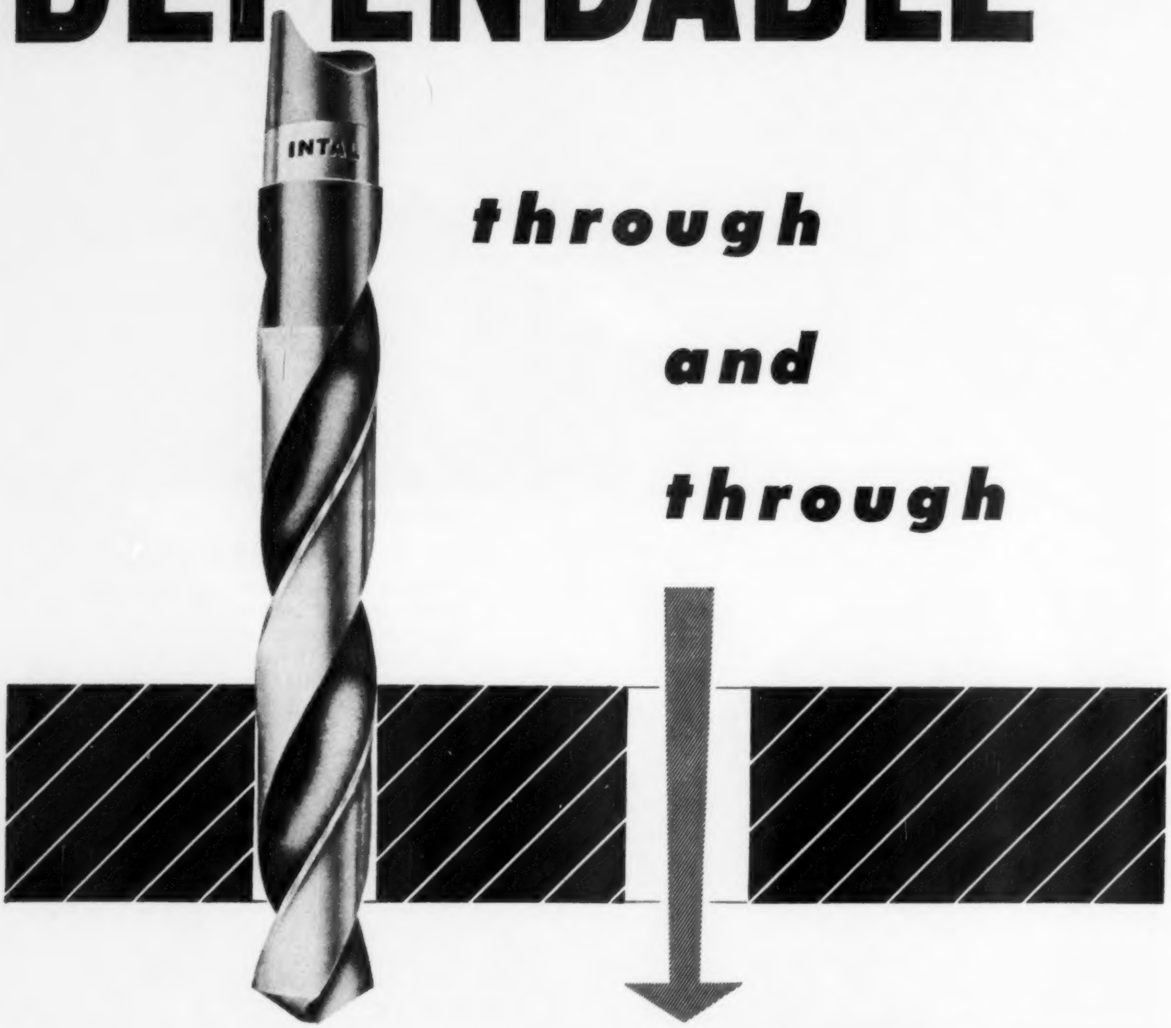
Excellent reference books are available on electricity and productivity (8/6 each, or 9/- post free)—'Materials Handling in Industry' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity including one on materials handling. Ask for a catalogue.

7923

CUT HERE

DEPENDABLE



through

and

through

London Office and Stock
6/9 Red Lion Market, Whitecross St., London, E.C.1
Tel: MONarch 8771-2

Birmingham Office and Stock
81 Headingley Road, Handsworth, Birmingham
Tel: NORthern 8211

Manchester Office and Stock
177 Dickenson Road, Manchester 13
Tel: RUSholme 7313-4

Scottish Agent and Stockist
John Warden, 50 Wellington Street, Glasgow C.2.
Tel: City 6994 (2 lines) Grams: Precise, Glasgow

INTAL
TWIST DRILLS

THE INTERNATIONAL TWIST DRILL CO. LTD. · INTAL WORKS · SHEFFIELD 3

Telephone 23072 (3 lines)

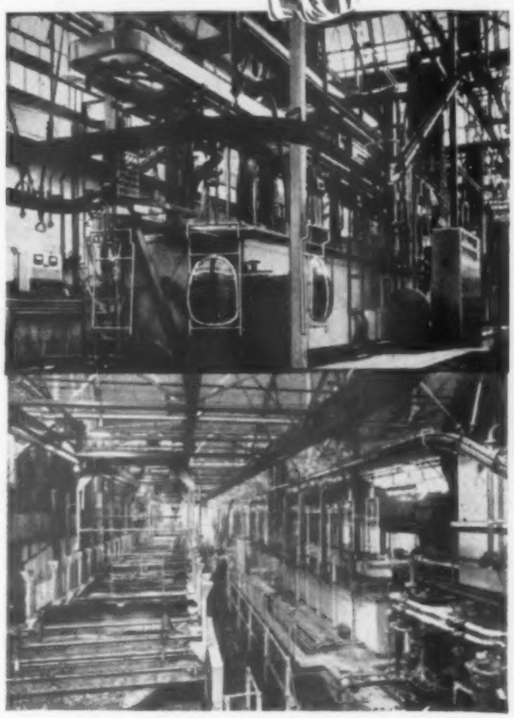
Telegrams: 'Fluted,' Sheffield

JAGUAR

use

Efco-Udylite

Plating Plant



Jaguar's high standards of plating quality on all body trim are met by two Efco-Udylite automatic plating plants and one Efco-Udylite hoist operated plant. A full description of the installation is available on request.

High temperature/ high ratio chromium plating is used in these Jaguar plants to give greater corrosion protection

CHOSEN FOR THE FINEST CAR OF ITS CLASS IN THE WORLD

NRP 3442

EFCO **ELECTRO-CHEMICAL ENGINEERING CO. LTD.**
SHEERWATER, WOKING, SURREY. Telephone WOKING 5222-7

RESEARCH AND DEVELOPMENT to keep the motorist

Constant research, unceasing development — in theory and in practice — that's the key to the unremitting progress made by Girling in the service of the motor industry and in the interests of safer motoring. No effort is spared in this quest for perfection to ensure that Girling do indeed make the Best Brakes in the World.

TRAVELLING WITH SAFETY

GIRLING

MANUFACTURERS OF THE BEST BRAKES IN THE WORLD

GIRLING LTD KINGS RD TYSELEY BIRMINGHAM 11

They've got to be GOOD

to be

there

there

and

there

Otter REGD.

reliable thermostats

WORLD PATENTS INCLUDING PATENT NUMBERS 600055, 622781 624905, 657434, 713443, 749716, 774911, 782668 AND OTHERS ALSO OTHER PATENTS PENDING

Water temperature warning. Choke control thermostats. Control of electric cooling fans. Unaffected by vibration because—OTTER thermostats PRESS their contacts together to OPEN them with a SNAP!

Photograph by courtesy of the Rover Co. Ltd. Jaguar Cars Limited. Lotus Cars Limited.

OTTER CONTROLS LTD

OTTERS 'OLE, MARKET STREET, BUXTON, DERBYSHIRE. Phone: Buxton 1745 (4 lines)

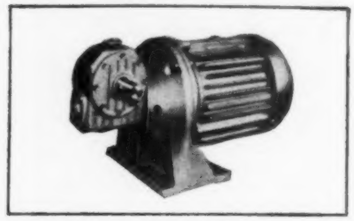
OI.

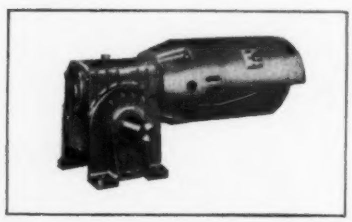
Vertical or horizontal, streamlined or functional

THE INCREDIBLY VERSATILE VERSO

This new Holroyd $2\frac{1}{4}$" centres motorised worm gear speed reducer has been designed to meet the need for a self-contained drive suitable for continuous use, and one which will look right in any surroundings. No matter what the application, it is possible to select from its variety of assemblies and mounting positions, an arrangement which makes it appear an integral part of the surrounding machinery, and *not* an added afterthought.

The Verso has all the famous features of Holroyd reliability and high efficiency. Centrifugally cast Holfos wormwheel; casehardened and profile ground alloy steel worm; ball bearings throughout; rigid cast iron casing and oil bath lubrication requiring no attention over long periods. Output speeds are from 14 to 300 rpm. Output torques up to 750 lb. ins. Standard motors from $\frac{1}{4}$ up to 2 hp. *Please write for catalogue V. 60 which gives further technical information.*



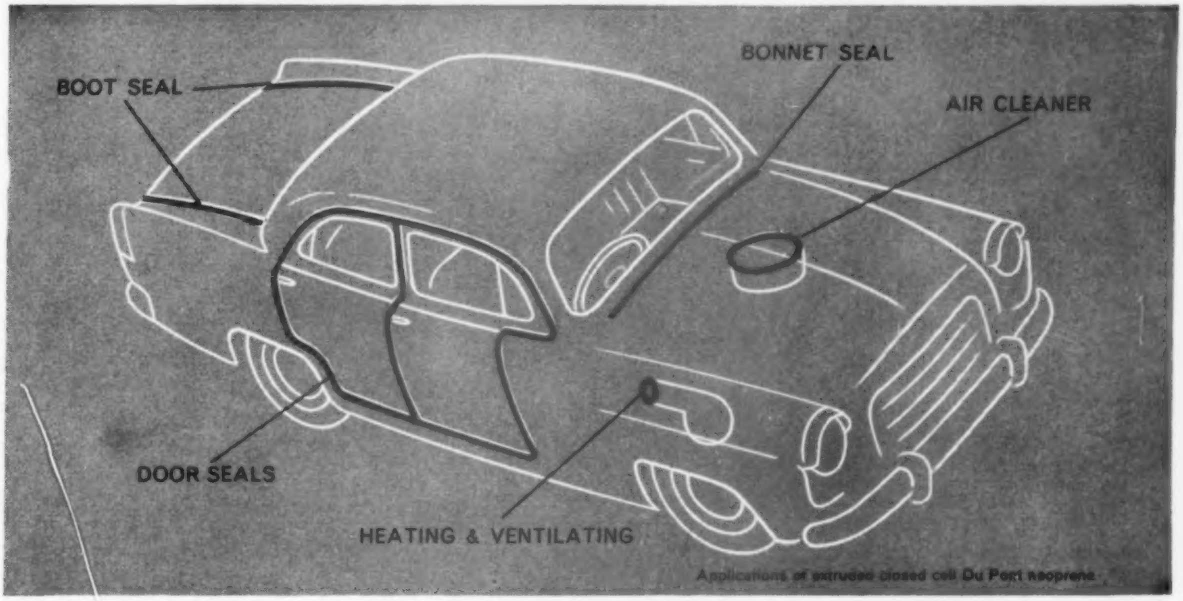


Holroyd

JOHN HOLROYD & CO LTD · MILNROW · ROCHDALE · LANCASHIRE

CRC B9

A new and improved body seal:
EXTRUDED CLOSED CELL **DU PONT NEOPRENE**



Applications of extruded closed cell Du Pont neoprene


Examples of complex cross sections which can be extruded

NEW APPROACHES TO BODY SEALING AND GASKETING are possible with extruded closed cell Du Pont neoprene. It can be extruded into low-pressure body seals of controlled softness that offer high resistance to ozone and weathering, and have low water absorbtion. The "self-skin" of these extrusions and the closed cell structure beneath remove the need for a protective coating. Tighter radii can be turned without wrinkling to provide an effective seal. For more information post coupon for your copy of 'Extruded Closed Cell Neoprene Sponge'.

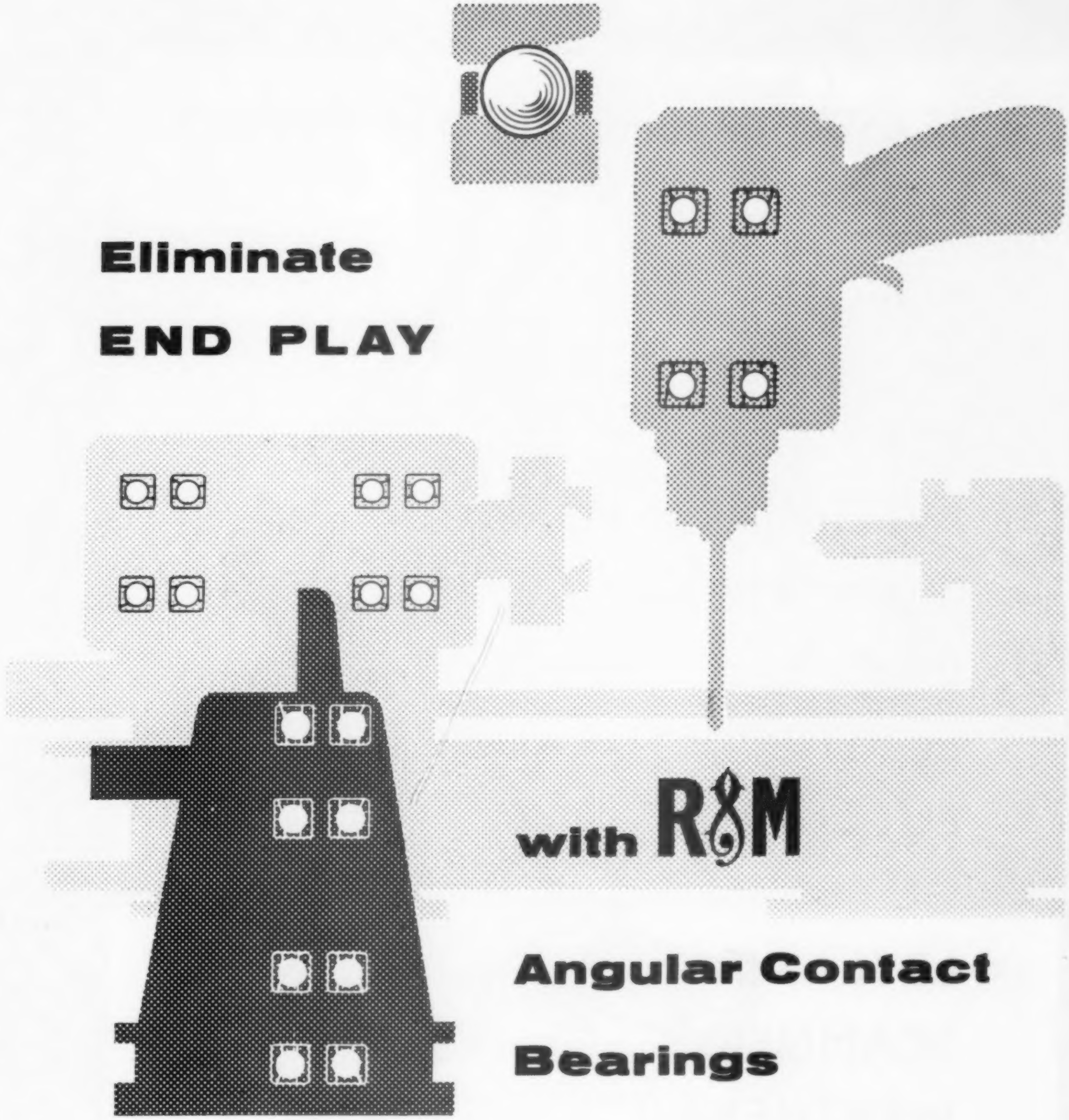
Du Pont Company (United Kingdom) **Ltd.,**
76 Jermyn Street, London, S.W.1

DU PONT **NEOPRENE**
REG. U.S. PAT. OFF.
ESTABLISHED 1802
BETTER THINGS FOR BETTER LIVING .... *THROUGH CHEMISTRY*

Du Pont Company (United Kingdom) Ltd.,
76 Jermyn Street,
London, S.W.1, England
Please send me the Du Pont booklet
'Extruded Closed Cell Neoprene Sponge'
Auto Engineer 11/61

NAME__________
POSITION__________ COMPANY__________
ADDRESS__________
CITY__________ COUNTRY__________


Now 'E' type models join the range
of JAGUAR cars
supplied with a continuous flow of over different
castings from our iron and aluminium foundries.
Many are produced in the large pressure-die casting
machines which supply cylinder blocks, clutch housings,
gear boxes and similar castings in aluminium,
effecting surprising savings in weight and machining costs.
West Yorkshire Foundries Ltd.
SAYNER LANE, LEEDS, 10. Telephone: LEEDS 29466.
London Office: Hanover House, Hanover Square, W.1. Phone: MAYfair 8561.



They meet the continuous high speed operation of a pump, maintain the precise setting of a lathe headstock, withstand the stop/start punishment of an electric drill—angular contact bearings are designed for every requirement of continuous thrust loading.

Ransome and Marles produce these bearings in a comprehensive range of sizes and tolerances. The designs can include built-in preload which eliminates shims or adjustments on assembly. The bearing specification can be arranged to suit the precise requirements of any particular application.

Ransome and Marles will be pleased to advise you on the application of angular contact bearings. Call them in when designing, developing or modifying machines of any type or size; their guidance is expert, impartial and confidential. Publication 37 is a comprehensive introduction to Ransome and Marles bearings.

BALL & ROLLER R&M BEARINGS

RANSOME & MARLES BEARING COMPANY LIMITED

NEWARK-ON-TRENT · NOTTS · TELEPHONE 456 · TELEX 37-626

- 4,000 Sparking Plugs marked per hour
- 1,800 Ball Pins marked per hour
- 1,400 Ball Race Rings marked per hour

by PLANETARY MARKING MACHINES

Capable: Periphery or flat end marking.

Adjustable: Can be hopper or hand fed.

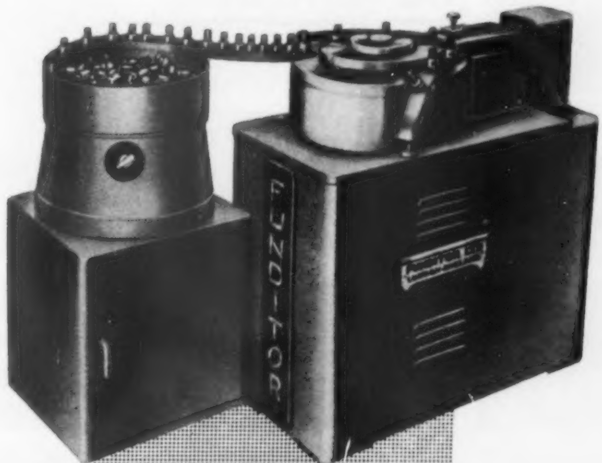
Versatile: Mandrel support for thin-wall articles, ball race rings, etc.

Uniform: Pneumatic Compensator ensures regular marking depth.

Automatic: Ejector Finger effects automatic ejection.

Simplicity: Typeholders easily set up for various operations

Accurate: Specific marking location if needed.



It's easy to create the right impression with...

FUNDITOR

PLANETARY MARKING MACHINES

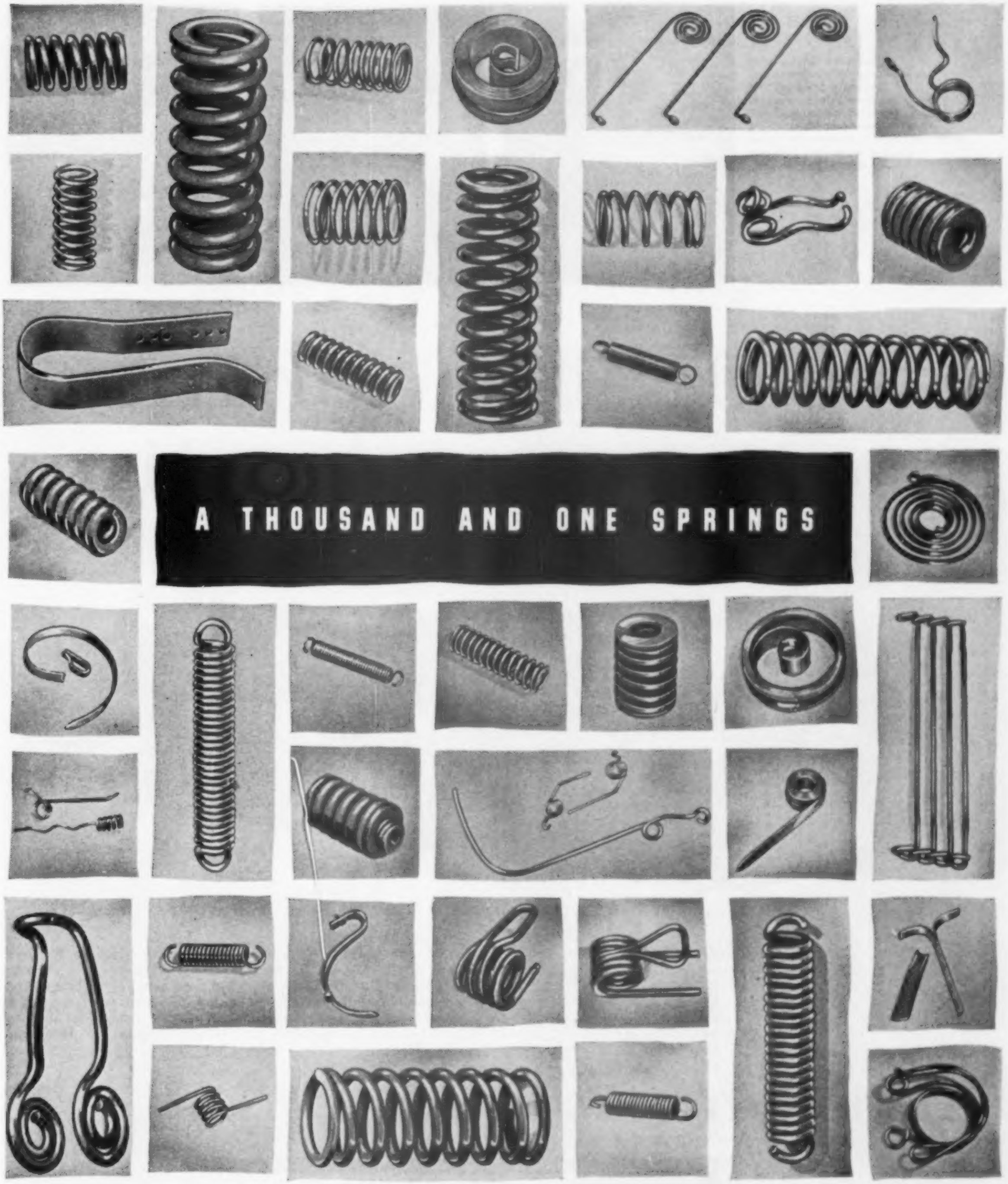
The most acceptable and economical results in High Production Marking are obtainable on Planetary Machines **alone.** Built around one or two basic units with 4, 6 or 8 workholding stations fulfilling the requirements of numerous marking operations. Purpose designed they are ideally suited for integration into existing production lines.

Electric lamp sockets, ball races, socket wrenches, bushes, small calibre ammunition, thinwall tubes, pressings with protruding lugs, ball pins, automotive parts, textile machine spindles, etc. etc.

FUNDITOR LIMITED

3 WOODBRIDGE ST., LONDON, E.C.1

Telephone: Clerkenwell 6155/6/7. Telegrams: Funditors, Cent, London



We design and supply all types of coil, compression, extension, torsion springs and presswork all individually produced to do a particular job. Our Technical Division is fully equipped to recommend the specific solution to meet your particular needs.

THE TEMPERED SPRING

COMPANY LIMITED

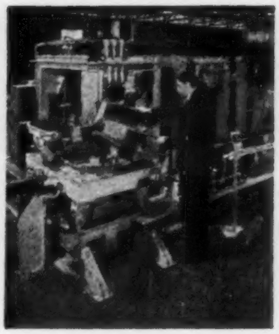
SHEFFIELD

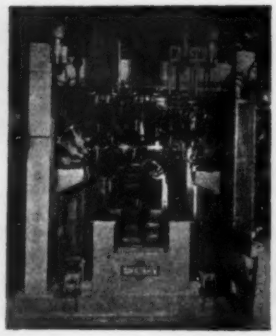
TELEPHONE 21333-4-5
TELEGRAMS
TEMPERED SHEFFIELD TELEX 54-103

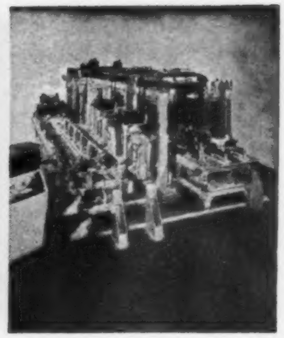
P. O. BOX 17
WARREN STREET
SHEFFIELD 4

A Member of the Tempered Group

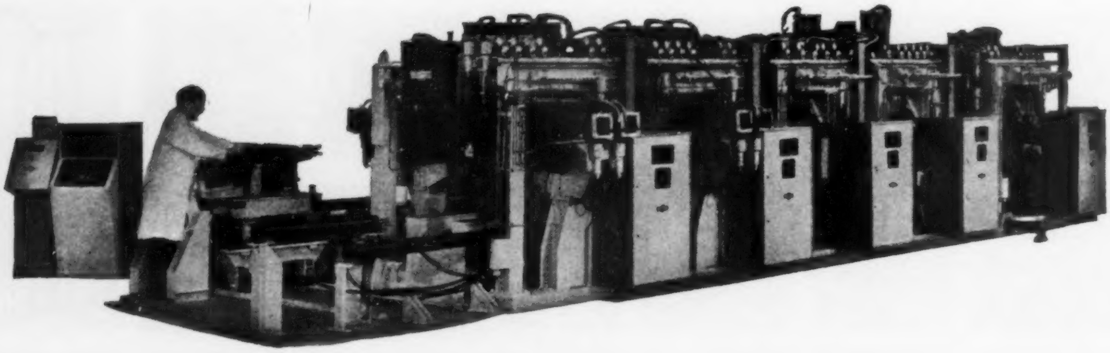
Illustrated is a transfer resistance welding machine, recently designed and constructed by Sciaky. It welds the front suspension and engine mounting units of the BMC mini cars in 5 stages. Welding cycle and transfer between stages is automatic.







a welding machine...
...a production line



Every day thousands of Sciaky Resistance Welding Machines are used to produce Britain's automobiles. Working closely with the motor industry, Sciaky has developed a range of welding machines to meet their critical requirements. But, the story does not end there . . . the adaptation of resistance welding to a specific application—the Sciaky technique—is yours for the asking. Let Sciaky experience and know-how work for you, because Sciaky resistance welding techniques are developed to meet your individual needs—whether portable, pedestal, or complete production line.

this is what SCIAKY resistance welding means

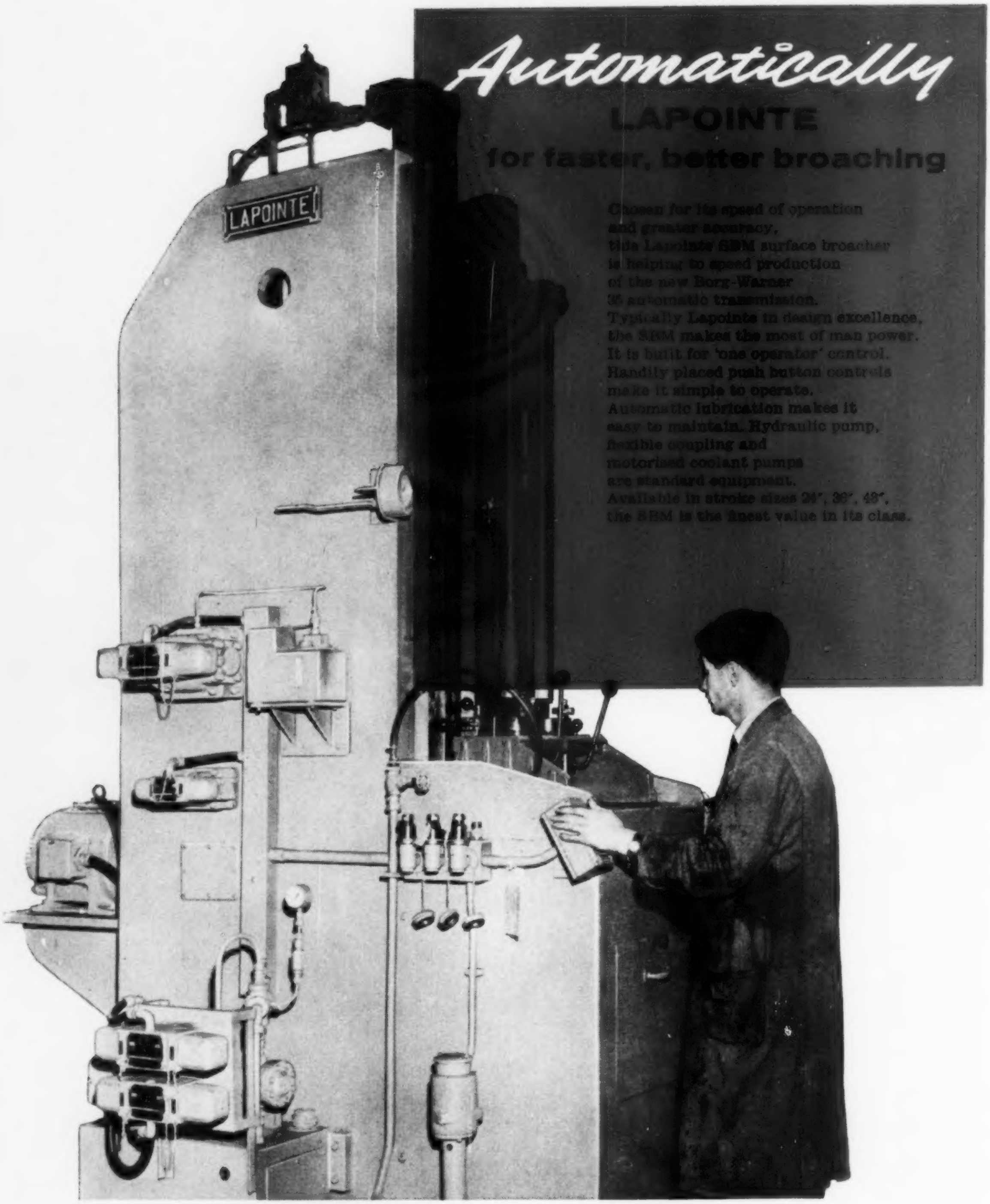
SCIAKY ELECTRIC WELDING MACHINES LIMITED
FALMOUTH ROAD (Trading Estate) · SLOUGH · BUCKS · *Telephone* 25551 (10 lines)

CAPE

CAPASCO

takes care of the braking

CAPASCO LIMITED · 114 & 116 PARK STREET · LONDON W1 · TELEPHONE: GROSVENOR 6022

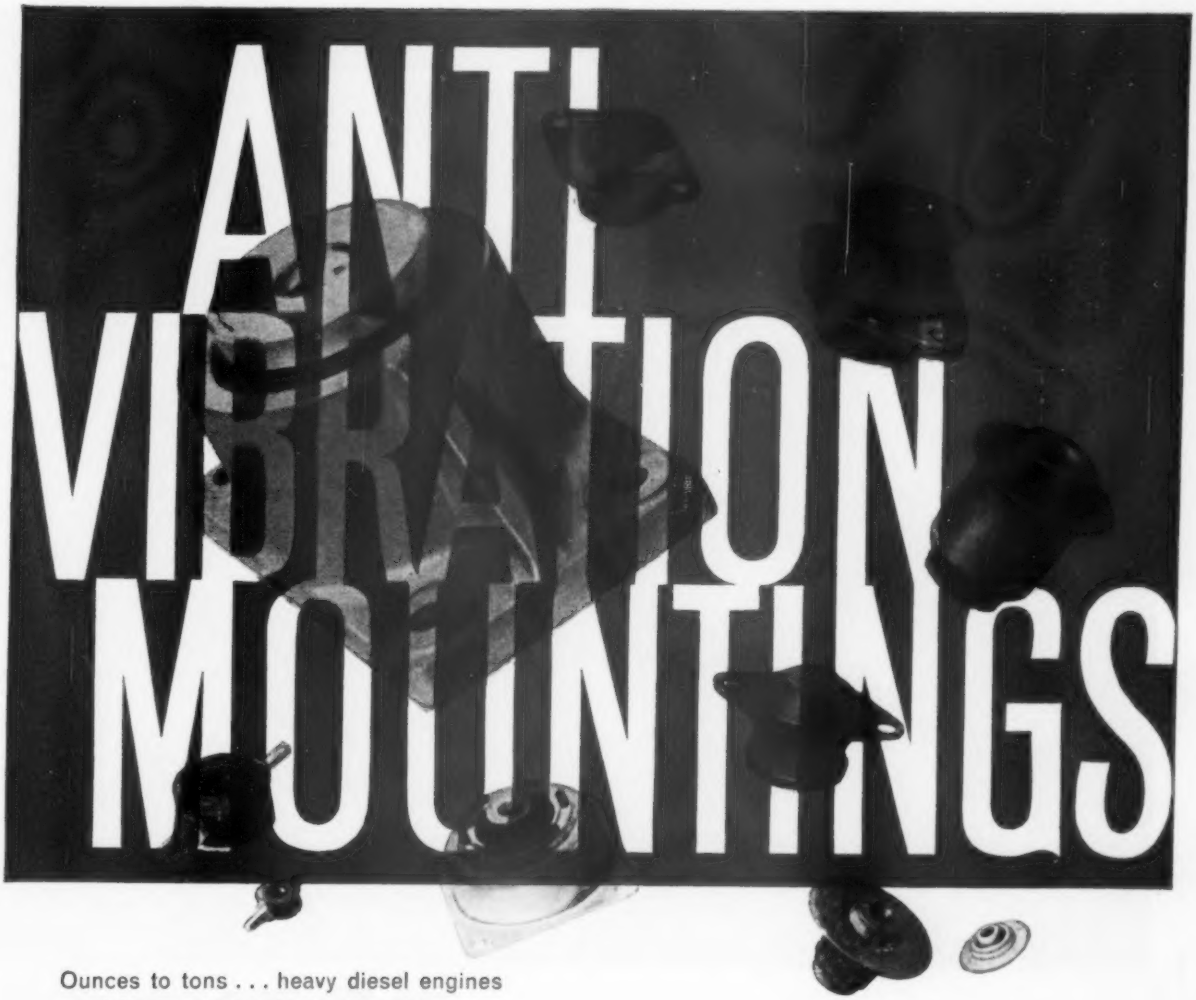


come to LAPOINTE for better broaching

British Made

The Lapointe Machine Tool Co. Ltd

Otterspool Watford By-Pass Watford Herts
Watford 31711 (4 lines) Cables: Lapointe Watford
Subsidiary: Lennie & Thorn Limited Bracknell Berkshire
also The Lapointe Machine Tool Company Hudson Mass. USA



Ounces to tons . . . heavy diesel engines to delicate electronic instruments . . . whatever the loading, whatever the working conditions, there is a Silentbloc Anti-Vibration Mounting to meet your need. Our standard range is so wide and varied that it can satisfy all but the really unusual demand; but "specials" can be designed and made to your own requirements more quickly and less expensively than you might suppose. Our advisory service is freely at your disposal without obligation.

SILENTBLOC

ANTI-VIBRATION DEVICES

Come to us at the drawing-board stage

FOR ROAD AND RAIL TRACTION
INDUSTRY · MARINE APPLICATIONS
INSTRUMENTATION · ELECTRONICS

SILENTBLOC LIMITED MANOR ROYAL CRAWLEY SUSSEX

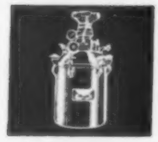
Telephone: Crawley 2100 *Telegrams: Silentbloc Crawley*

Andre Rubber Co. Ltd., is another Silentbloc Company. Silentbloc products are also manufactured by Silentbloc (Australia) Pty. Ltd., Melbourne

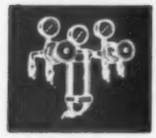
Broadway S.112

A.I.D. manufacture a complete range of industrial finishing equipment

SPRAY GUNS

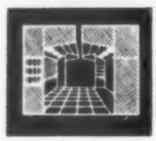


PRESSURE CONTAINERS



TRANSFORMERS

COMPRESSORS



SPRAY BOOTHS

A better finish — cheaper — faster. That, in a nutshell, is what we of AID offer you.

Better — cheaper — faster. Three words that are muttered by AID technicians in their sleep.

Better — cheaper — faster. Three words that have put AID out in front in the finishing field.

AID have developed fatigue-free guns with perfect atomisation, long-lived compressors with consistent delivery, spray booths exactly matched to the needs of particular industries, complete installation tailor-made for the job.

For the gun — and everything behind the gun — it's a good idea to call in AID. Helpful literature and technical assistance are always freely available.

AIR INDUSTRIAL DEVELOPMENTS LIMITED

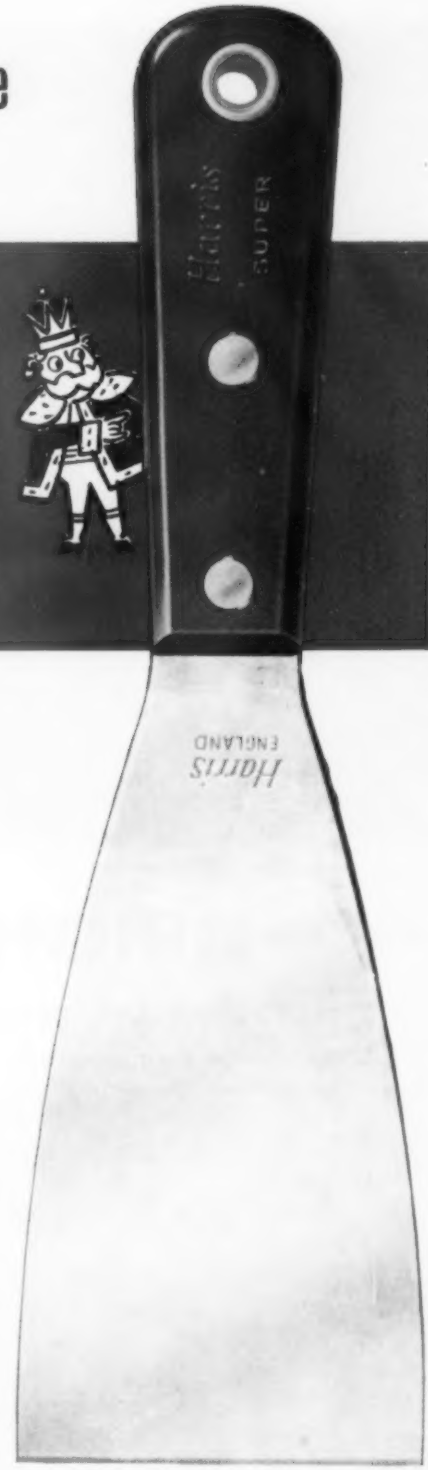
AIDSPRAY WORKS, SHENSTONE, NR. LICHFIELD, STAFFS., ENGLAND

Phone: Shenstone 341/5 Grams: Aidspray, Shenstone. Canadian Office: 45 Palamino Crescent, Willowdale, Ontario.

London Office: 3 CHESTER MEWS, LONDON, S.W.1. *Phone: Belgravia 1980*


COMPOSITE VEE VICE
SURFACE GAUGES
ANGLE PLATES
VEE BLOCKS
TAP
WRENCH
CHUCK TYPE
TAP
WRENCH
ADJUSTABLE
BAR TYPE
PIN VICES
VEE
BLOCKS
& CLAMPS
SCRIBERS
AUTOMATIC
CENTRE PUNCH

I.C.I. Heat Treatment joins the *Harristocracy*



To professional decorators and "do-it-yourself-ers", Harris has long been a name to conjure with—or, rather, to decorate with.
And Harris, naturally, are determined that this state of affairs should continue—and even grow, both at home and overseas.
That's why they introduced a mirror finish for all their scrapers—and why they devised a blade hard enough to retain its edge, yet capable of being bent without breaking. It's a super-strong tool, with long-life sharpness, hollow-ground for extra flexibility, and mirror-finished for easy cleaning.
And Harris's new scraper could not have been produced without I.C.I.'s 'Cassel' Ajax Electric Furnaces to provide the heat-treatment. Harris used to blank out their scraper blades from hardened and tempered strip; tool wear and maintenance was considerable—and production of the new blades at the required hardness would have been impossible. So Harris consulted I.C.I. Heat Treatment Service and installed their own heat-treatment plant.
Now, they blank out from annealed strip, and follow up with heat-treatment to give the desired hardness.
By using their own heat-treatment plant, Harris are able to ensure the clean surface necessary for mirror finishing; optimum hardness with minimum distortion and a blade sufficiently flexible, after hardening, to be pulled flat in the temper setting jig. Tool life at the blanking stage has been spectacularly lengthened and maintenance reduced to a minimum.

Harris would certainly agree that

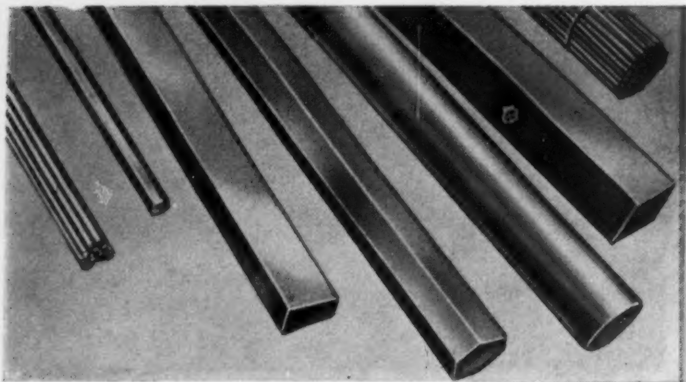
IT PAYS TO CONSULT I.C.I. HEAT TREATMENT SERVICE

ICI

GENERAL
CHEMICALS
DIVISION

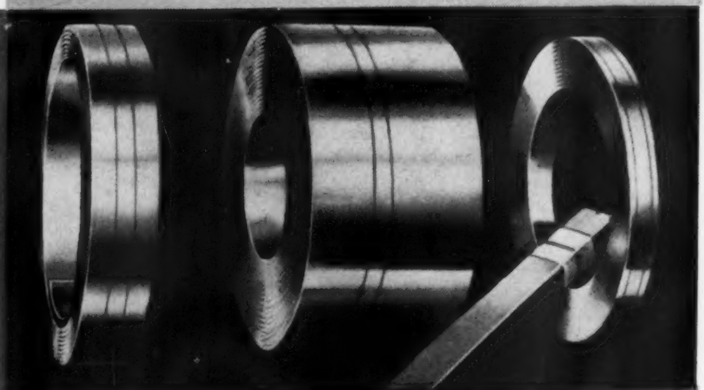
IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1.

CC.210



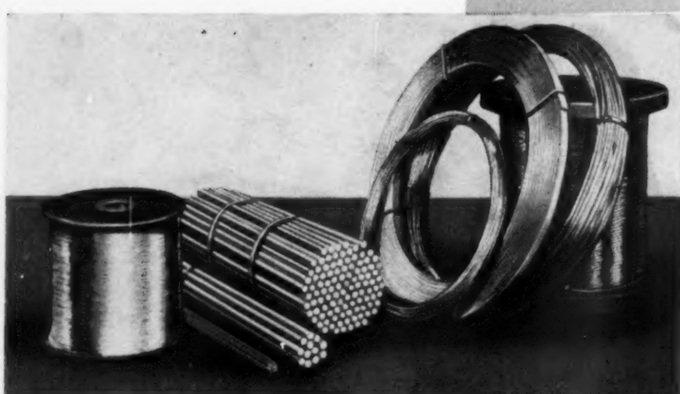
Bright Drawn or Turned in Rounds, Squares, Hexagons. Flats and Special Sections, in Freecutting Steel and most E.N. Specifications. Precision Ground also supplied.

ARTHUR LEE & SONS LTD



BRIGHT STEELS

Drawn and Rolled for all purposes



Cold Rolled up to 18 inches wide by any thickness in all Tempers, Coils, or cut to lengths. Special Deep Drawing Quality • High Carbon Quality for Hardening and Tempering • Stainless Steel Strip.

Steel supplied to Air Ministry and other Government specification

High Tensile Spring Wires, Flat Wires, in all qualities. Stainless Steel Wires.

ARTHUR LEE & SONS
LIMITED
SHEFFIELD
Telegrams: Crown, Sheffield.
Telephone: 387272

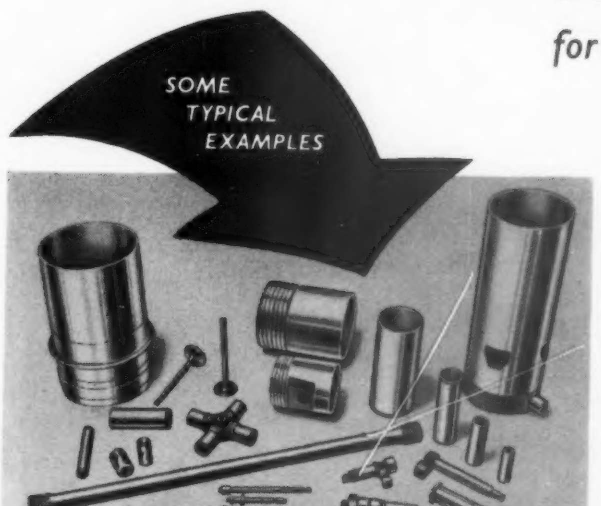
LONDON W.C.2 Stafford House,
40/43 Norfolk Street, Strand,
Telephone Nos.: Temple Bar 7187 and 7188

BIRMINGHAM 4 191 Corporation Street,
Telephone Nos.: Central 6801 and 6802

LIDKOPING

CENTRELESS GRINDING MACHINES

for accurate, high-output production



The type 4B machine illustrated is widely employed for production of automobile components and is also a popular machine for the electrical and textile industries, in fact, wherever high output, close tolerance centreless grinding is required.

The grinding and regulating spindles are supported at both ends in super-precision roller bearings of equal resistance and the grinding wheel spindle drive is through a torsion bar to relieve the spindle of belt tension. The range of work diameters which can be ground on the 4B machine is 0·04 in.—6 in. and maximum length for infeed work is 11·8 in.

Write to-day for full details of the Lidkoping range of centreless grinding machines.

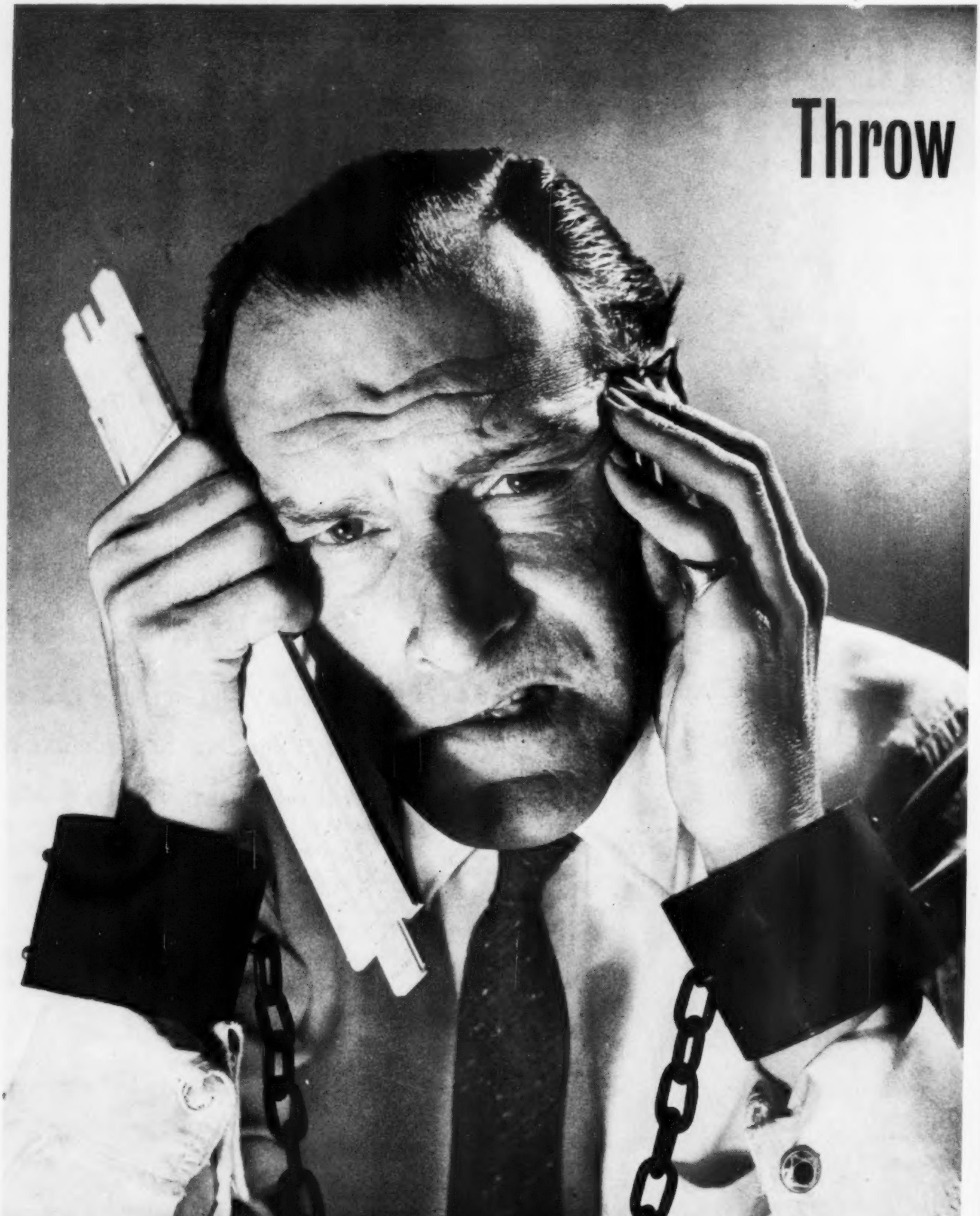
Sales and Service for the British Isles

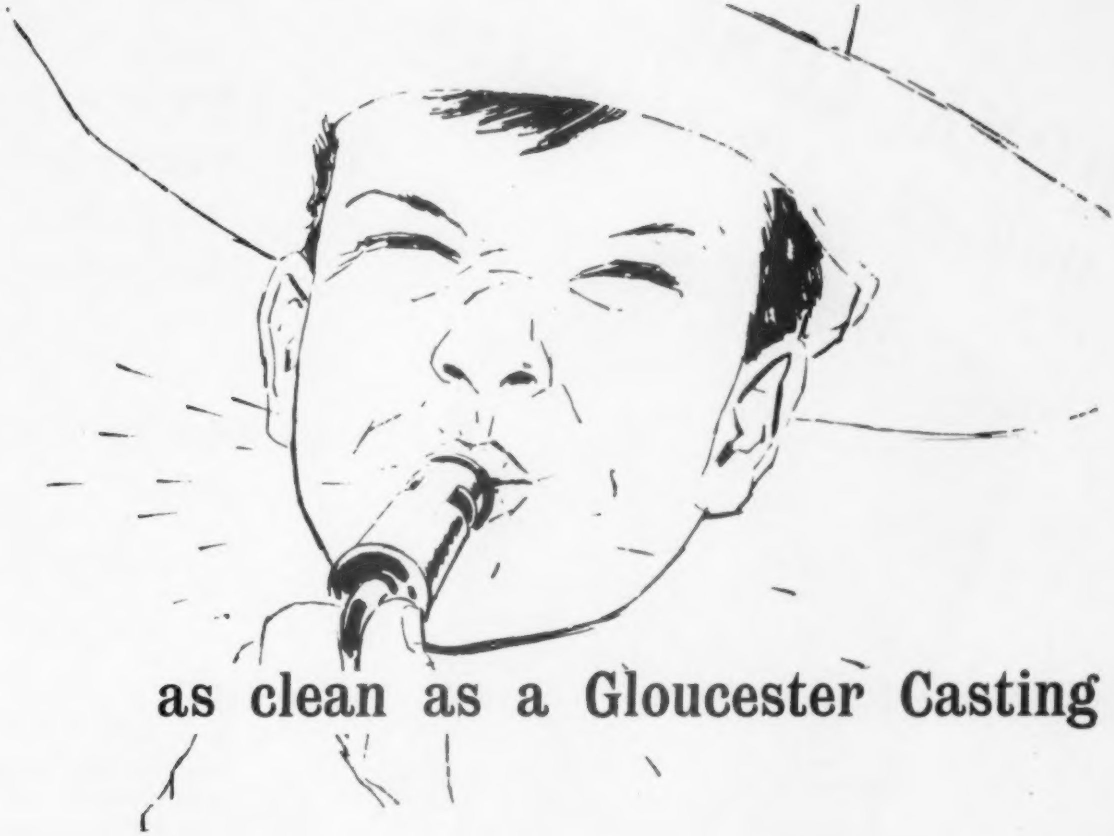
DRUMMOND-ASQUITH LIMITED

Member of the Asquith Machine Tool Corporation

KING EDWARD HOUSE, NEW ST., BIRMINGHAM. *Phone: Midland 3431.* Also at LONDON *Phone: Trafalgar 7224* & GLASGOW *Phone: Central 0922*

IF 322

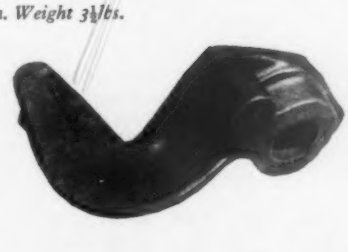

Throw



as clean as a Gloucester Casting

Brake shoe for small vehicle in Malleable Iron.

Bearing bracket in Malleable Iron. Weight 3½lbs.



"As clean as a Gloucester Casting" **means** that Gloucester malleable iron castings are of high definition, true to pattern, cleaner and smoother because of better sand practice and better fettling.
Mould and core sands and their bonding additives are under constant laboratory supervision, even the very sand grains are sized and numbered, and consistency and distribution of sand are strictly controlled by a continuous mechanical unit. The high refractory characteristics prevent sand "burn-on" at re-entrant angles, thus greatly increasing the life of cutting tools during the machining process. The new elevator-type electric furnace anneals in 48 hours —instead of the usual 7 days. It also allows greater control of the component during annealing, resulting in uniformity of metal, greater strength, and resistance to impact.

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation ..	18%	Elongation ..	5%
Yield Point ..	12 tons	Yield Point ..	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi

GLOUCESTER THE HOME OF GOOD CASTINGS

GLOUCESTER

Gloucester Foundry Ltd., Emlyn Works, Gloucester · Telephone: Gloucester 23041 · Telegrams: 'Pulleys' Gloucester

TEC-ELEMENTS Biggest ever filtration area, most effective filtration, longest working life . . . best engine protection. Recommended and fitted as original equipment by the vast majority of British car manufacturers.

TECALEMIT RIBBON FILTER ELEMENTS Finest filtration at lowest cost of air, water, petrol, diesel and fuel oils, lubrication, hydraulic — just about every fluid you'd like to mention.

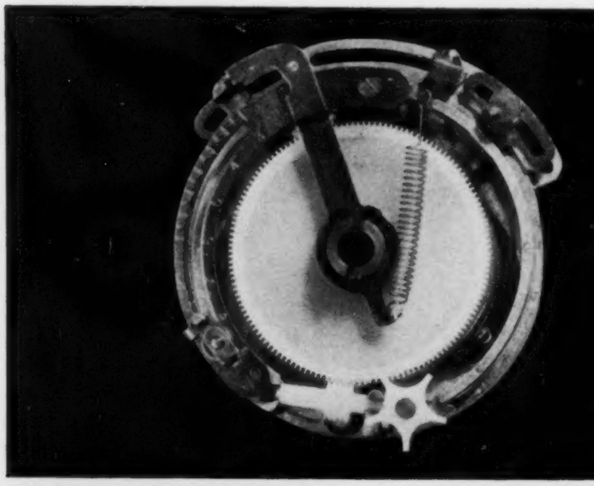
TECALEMIT NYLON TUBING Outperforms metal, other plastics and rubber tubing for strength, flexibility, vibration-resistance, chemical and corrosion resistance. This is precision high pressure tubing and it is making a big difference in hydraulic brake hose techniques. It is also used as oil or fuel lines by Aston-Martin, Austin, Ford, Jaguar and other leading manufacturers.

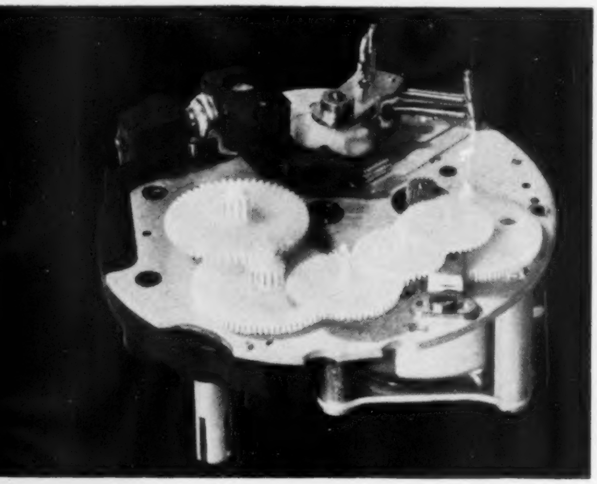
TECALEMIT

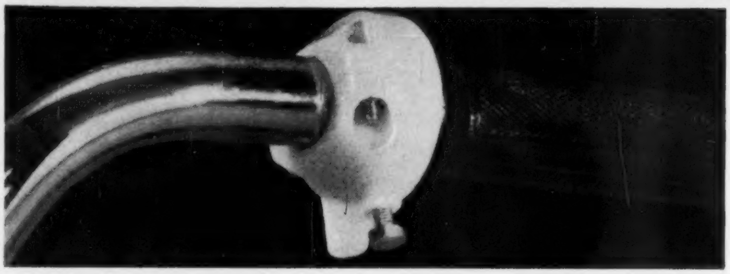
THE AUTHORITY ON LUBRICATION AND FILTRATION

TECALEMIT · PLYMOUTH · DEVON · Telephone: PLYMOUTH 62844


REGISTERED
TRADE MARK
OAKENSTRONG
OAKENCORK
OIL and PETROL
GASKET MATERIALS
ALL ENQUIRIES TO
H. JACKSON LTD
OAKENCLOUGH, GARSTANG
Nr. PRESTON, LANCS.
Tel: Garstang 3308
Telex: Jackson, Grstang 67558
INVERESK
GROUP







Gears for time-switch by Sangamo Weston Ltd.; extra dimensional stability and mechanical strength were essential. Moulded Delrin components have replaced brass

Delrin motor-cycle twist-grip housings, made by J. & E. Courtney Ltd. for Doherty & Ashby. Moulded in various attractive colours, they replace heavier chrome-platedcastings,eliminatecorrosionproblems

In these uses (and many others) Delrin *replaces metal

In a wide range of applications where metal was once standard—iron, steel, brass, aluminium, zinc—DELRIN, the new Du Pont acetal resin, is now being used.

The design and engineering possibilities that DELRIN offers cover a great variety of uses and you will find an increasing number of parts moulded of DELRIN in diverse industries—the automotive, textile, hardware, plumbing and business machine industries, etc. This is because DELRIN combines so many excellent properties—among them strength, stiffness, dimensional stability and resistance to solvents and high temperatures.

DELRIN HAS:

	OVER TEMPERATURE RANGE —40°C —40°F +125°C +258°F
1. High tensile strength	13,000 psi to 4,000 psi
2. High modulus of elasticity	445,000 psi to 89,000 psi
3. Good impact strength	Izod. 1.2 to 1.4 ft.lb/in.
4. Excellent resistance to fatigue	5,000 psi 73°F
5. Resistance to solvents	Good throughout range
6. Abrasion resistance	Good throughout range
7. Moisture absorption	Low throughout range
8. Colourability	Excellent: colours do not affect properties
9. Coefficient of friction (unlubricated)	Uniform at 0.2 ± 0.1

Please send further information on:

☐ DELRIN* —acetal resin
☐ ALATHON† —polyethylene resin
☐ LUCITE† —acrylic resin
☐ TEFLON† —fluorocarbon resin
☐ ZYTEL† —nylon resin

NAME..

COMPANY..

ADDRESS..

Du Pont Co. (U.K.) Ltd., 76 Jermyn Street, London, S.W.1.

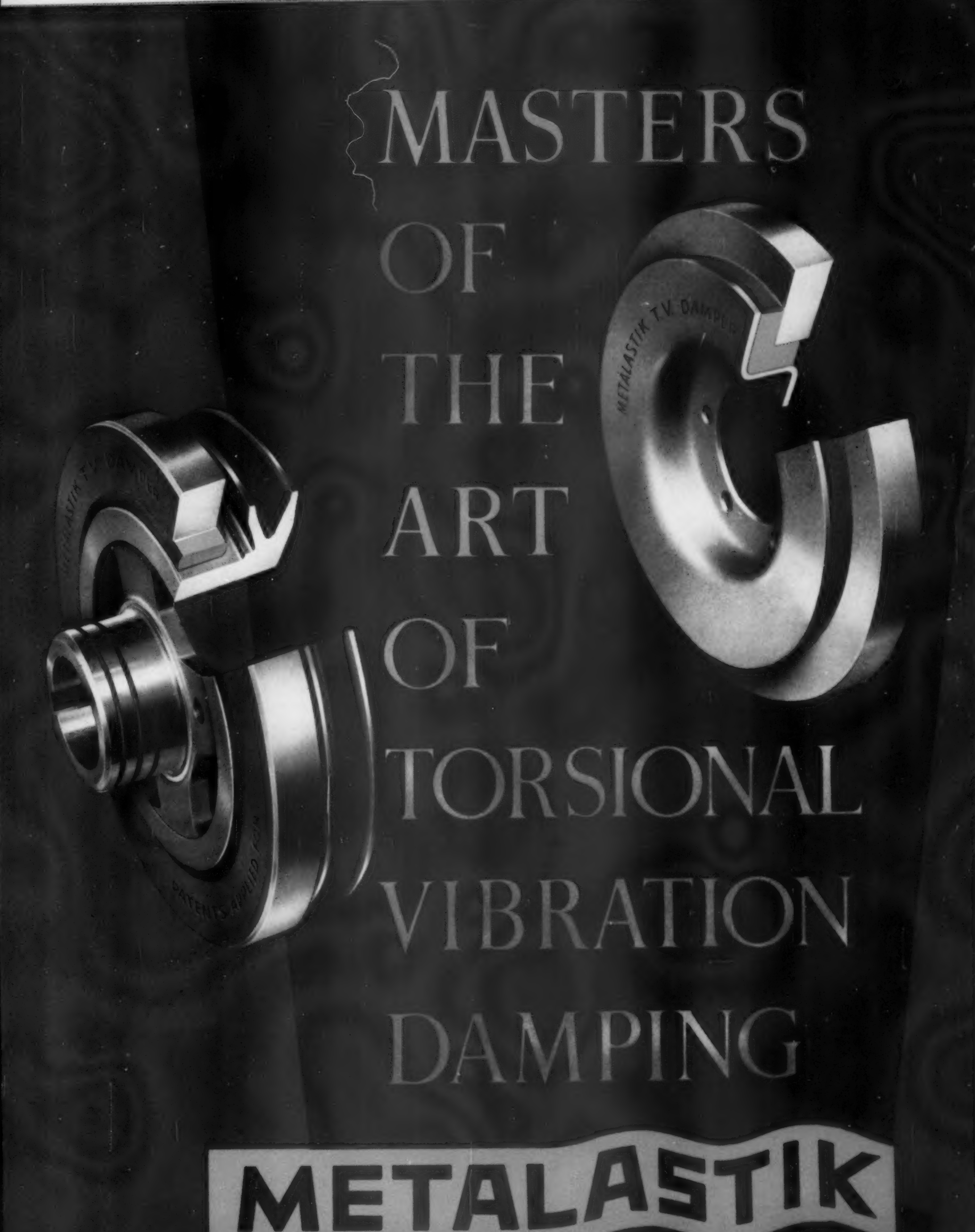
Plastics

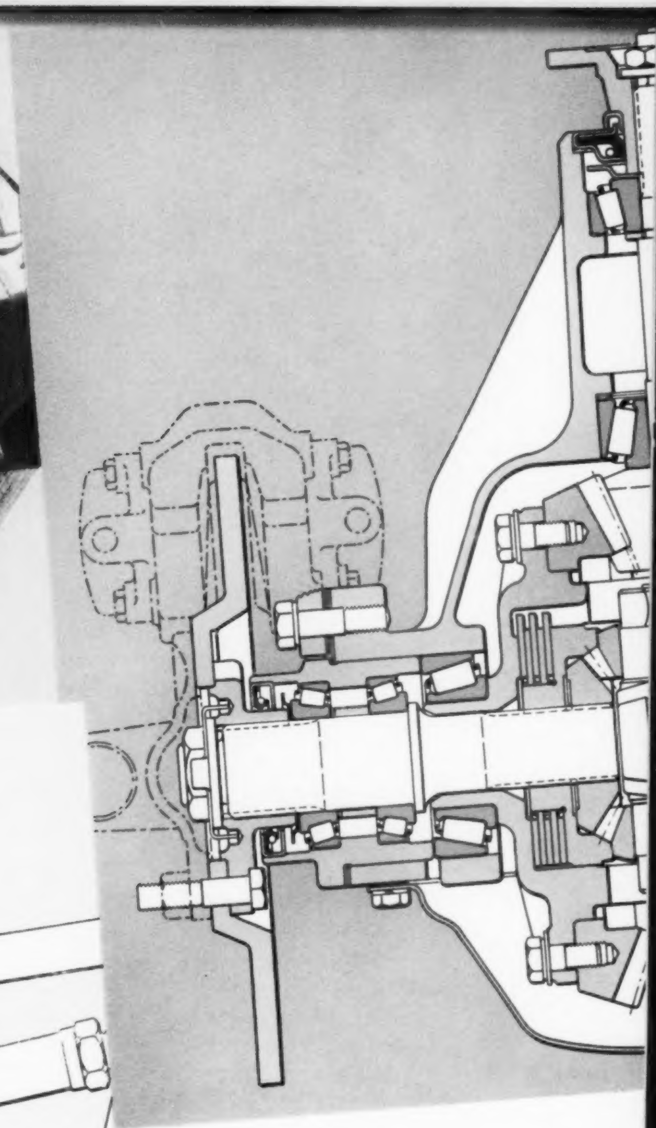
DU PONT

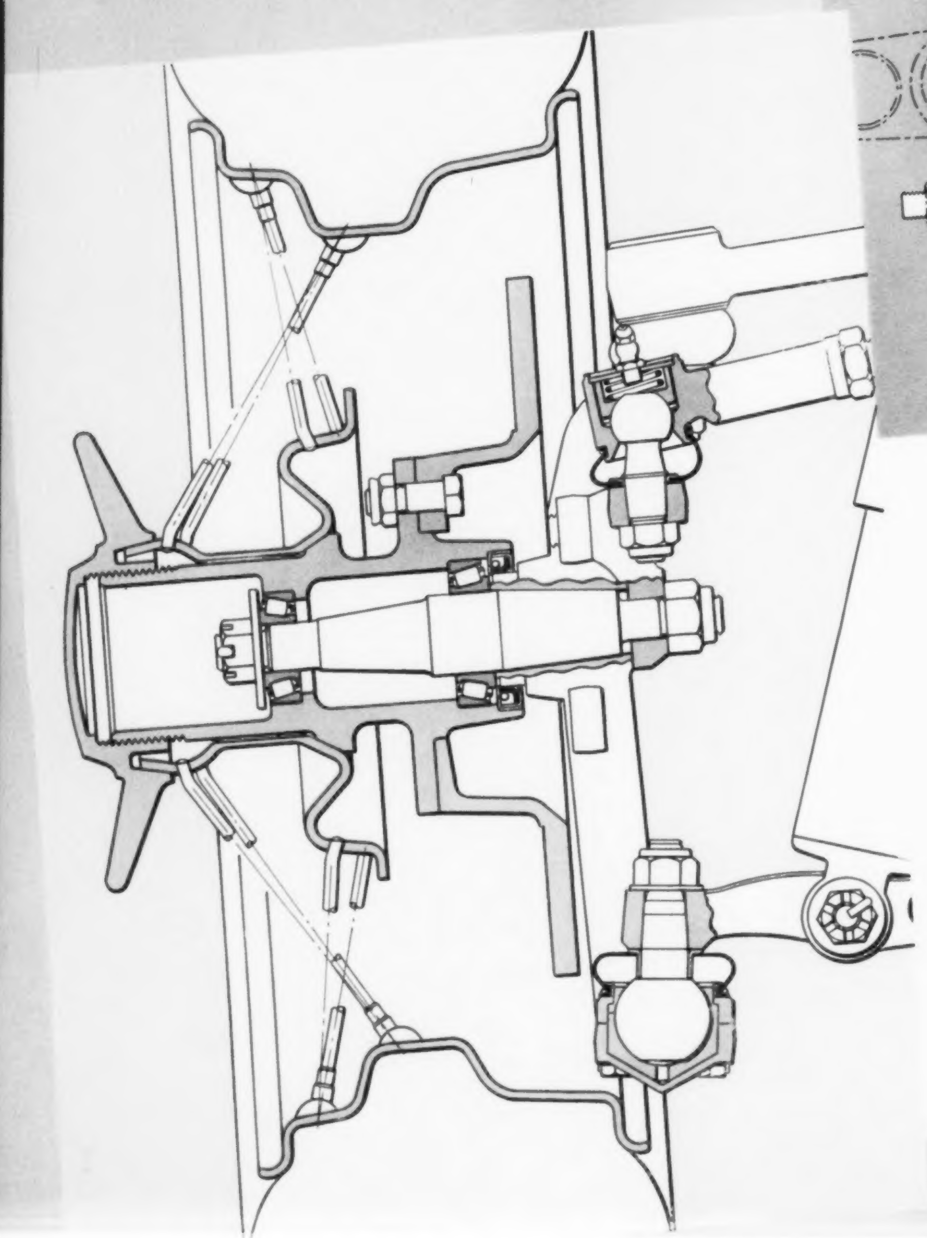
REG. U.S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

* **Delrin** is Du Pont's registered trademark for its acetal resin.
† Du Pont registered trademarks.


MASTERS OF THE ART OF TORSIONAL VIBRATION DAMPING
METALASTIK T.V. DAMPER
PATENTS APPLIED FOR
METALASTIK
METALASTIK LTD., LEICESTER
M290

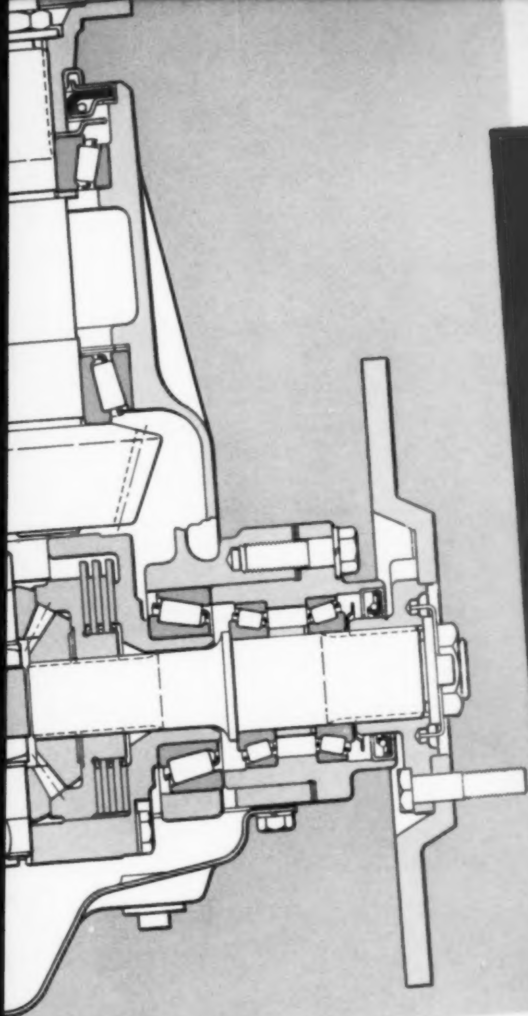


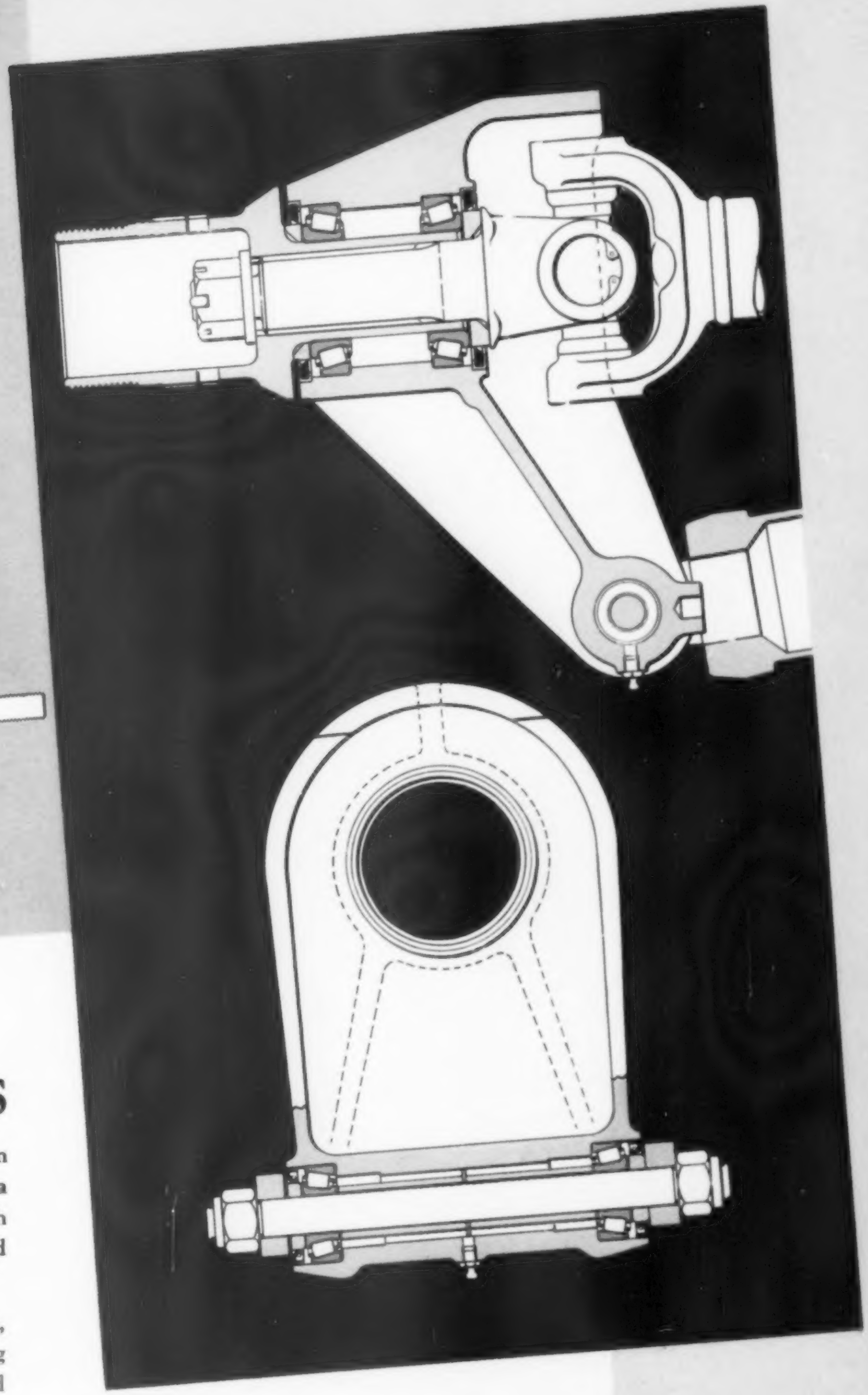


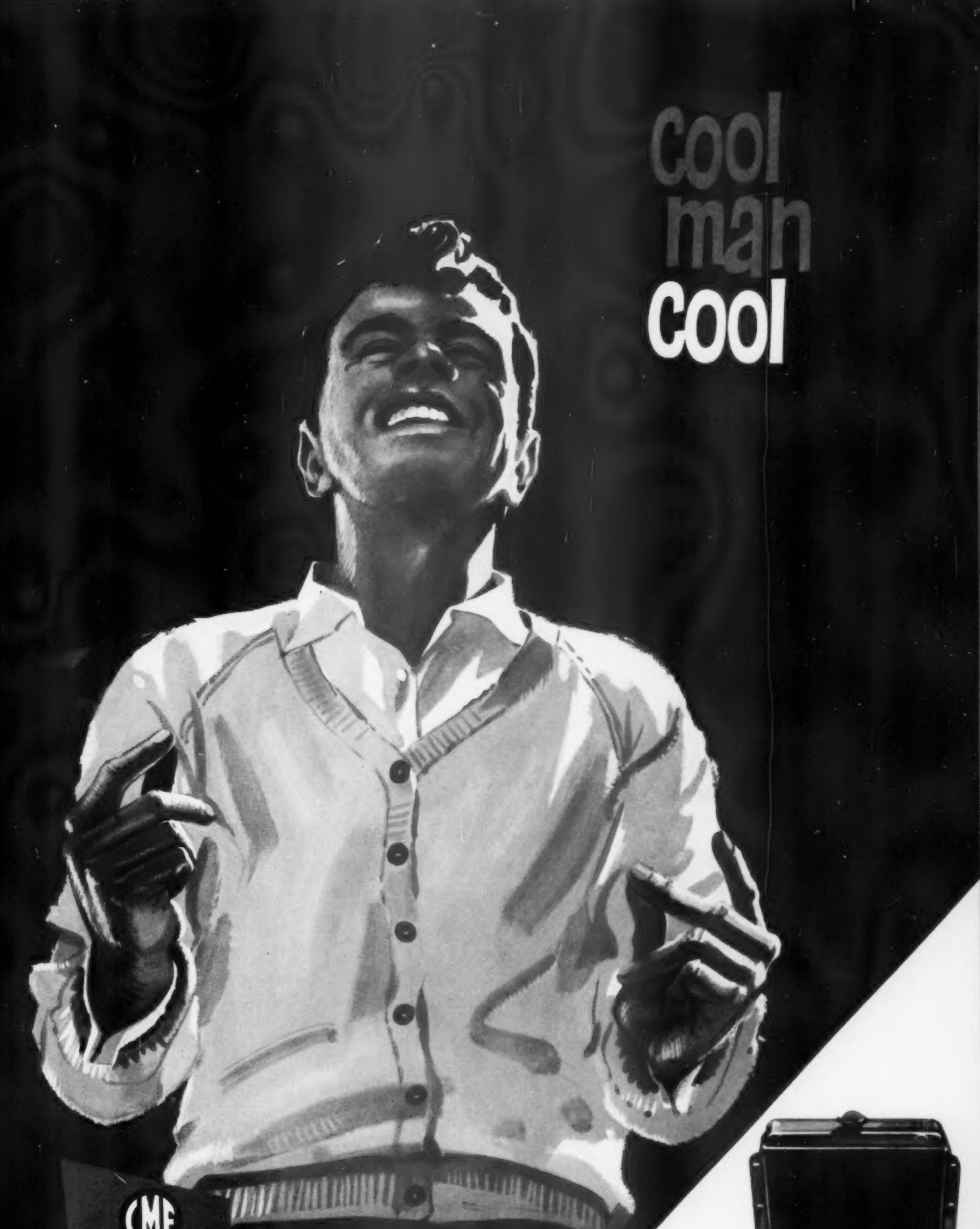
Interesting

In the new E-type Jaguar there are some interesting departures in design. The Salisbury final-drive unit—incorporating a Powr-Lok differential—has 'quarter-shafts' carrying the brake discs and universal joints. End location of the road wheels is effected by the cardan shafts, which also function as links in the suspension system; the journal and thrust loads arising from this arrangement are met by pairs of Timken bearings without loading the pair carrying the differential cage.

The rear suspension linkage is completed by tubular members journalled at their outboard ends to the rear-wheel bearing



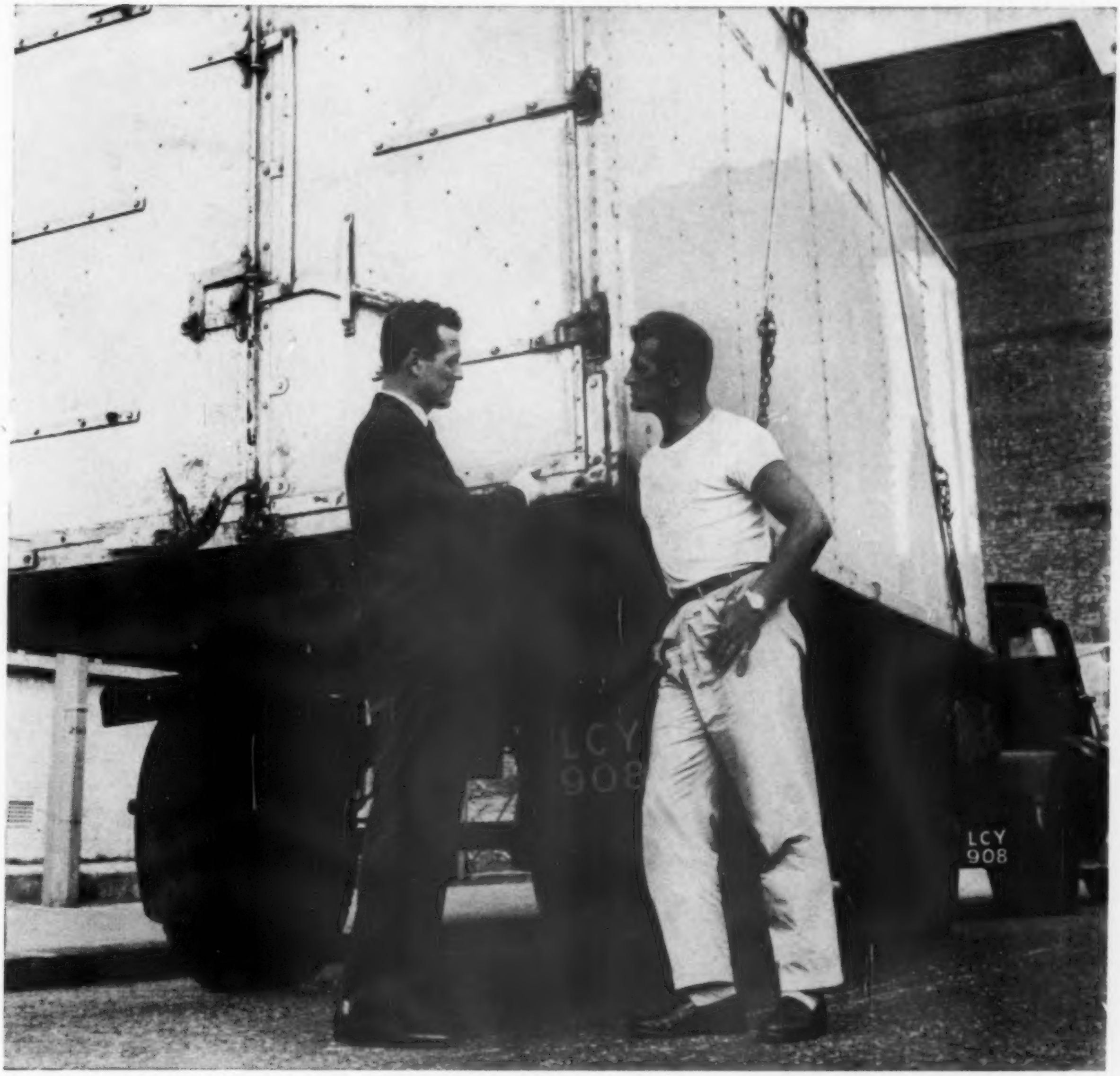



cool
man
cool
CMF
COVENTRY MOTOR FITTINGS
CO LTD
RADIATOR MAKERS SINCE 1902
A TYPICAL SMALL CAR RADIATOR

Road sense Transport Insulation with POLYURETHANE RIGID FOAMS

made from I.C.I. ISOCYANATES AND POLYESTERS.
Ask for details of Daltolacs 21, 22, 24, and 41 and Suprasec D℗.
Polyurethane foams provide excellent thermal insulation in all transport vehicles.
They combine high thermal resistance with lightness, strength and low inflammability.
Polyurethane foam components can be mixed on the site and poured or sprayed into position.
The foams withstand vibration and adhere so firmly to
adjacent surfaces that they actually strengthen the structure in which they are employed.
℗ Patented in the main industrial countries.

Enquiries should be addressed to: I.C.I. Sales Development Dept. (Polyisocyanates), Ship Canal House, King Street, Manchester, 2.



rigid
POLYURETHANE
foams

IMPERIAL CHEMICAL INDUSTRIES LIMITED LONDON SW1 ENGLAND

X185

Unbroken record

The manufacture of intricate aluminium castings for the very advanced Jaguar twin overhead camshaft engine has always been entrusted to William Mills, who continue to supply these castings for the Mark 10, latest of the Jaguar range.

William Mills Limited,
Friar Park Foundry,
Friar Park Road,
Wednesbury, Staffs.
Telephone: Stonecross 2651

Aluminium alloy castings by William Mills Limited

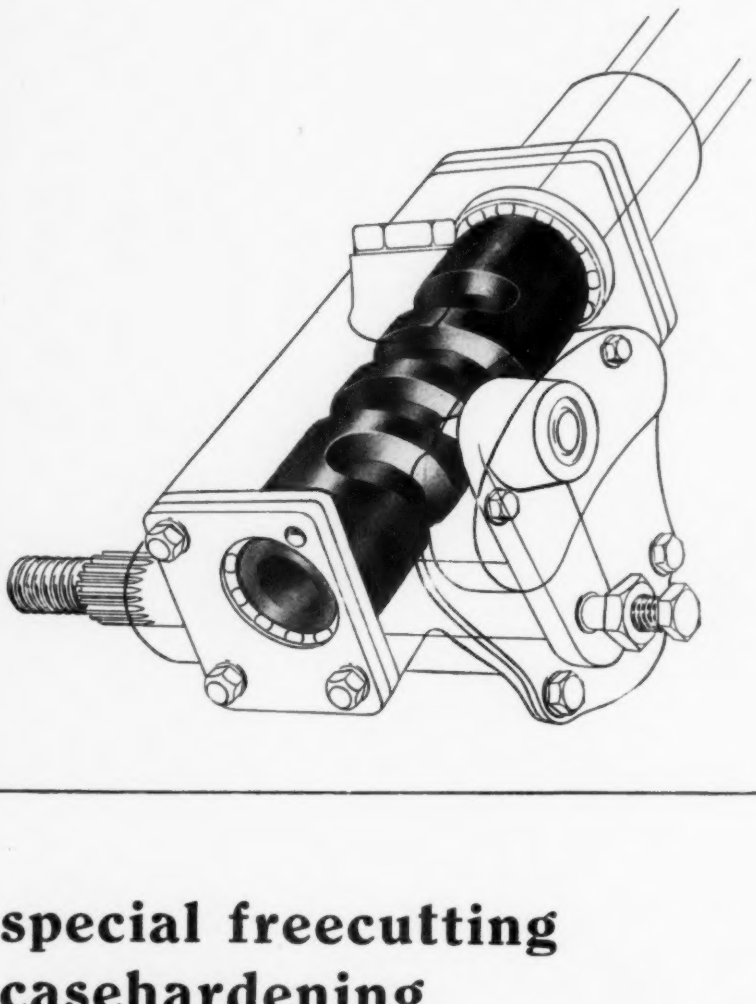
AP 113


Leadership
the BIRFIELD
. . JOINT

PARK GATE

QUALITY STEELS FOR AUTOMOBILE ENGINEERING

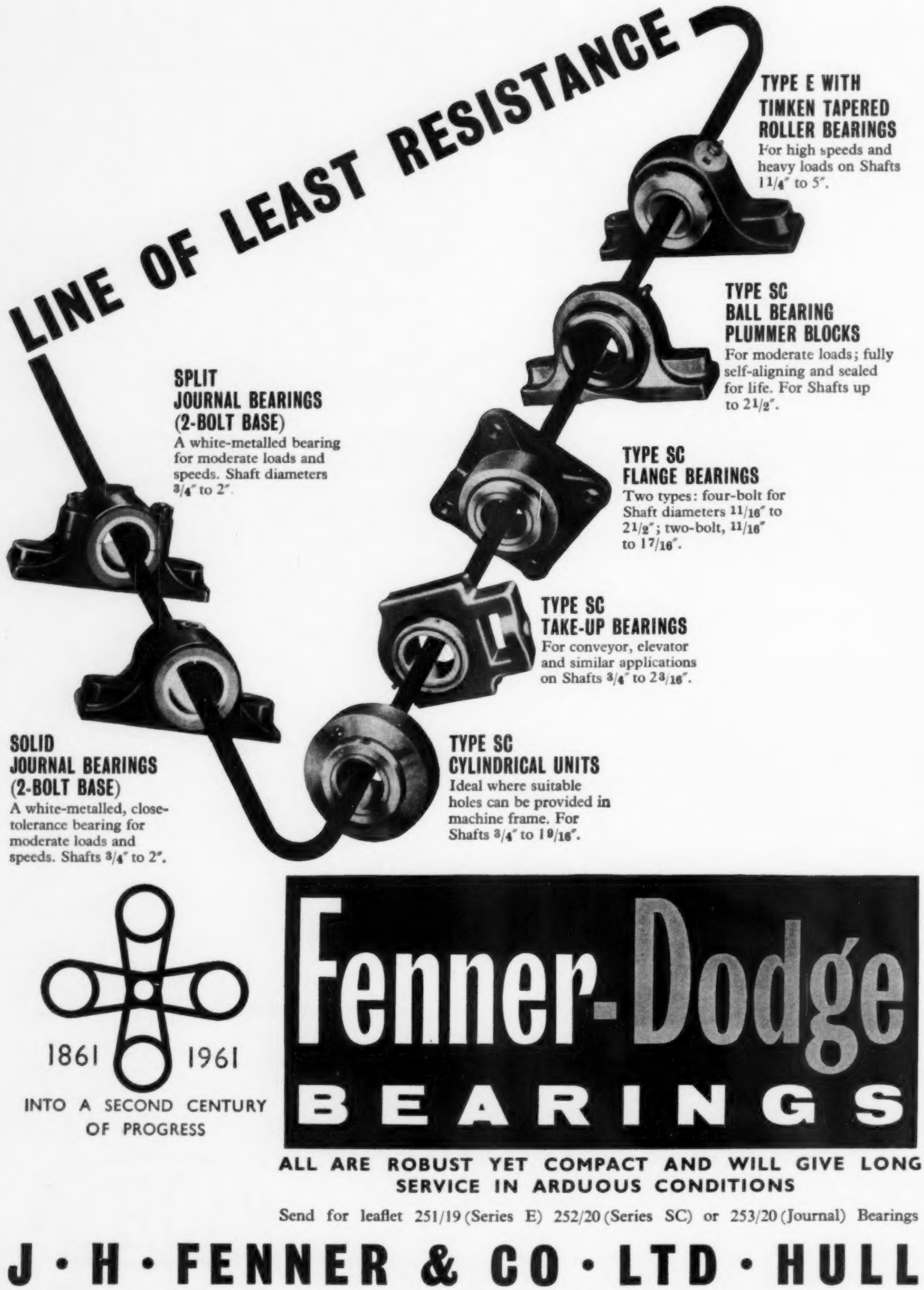
1823 1961
EXPERIENTIA DOCET



special freecutting
casehardening
quality bars

THE PARK GATE IRON & STEEL COMPANY LIMITED ROTHERHAM
A TI Company TEL: ROTHERHAM 2141 (15 lines) GRAMS: YORKSHIRE, PARKGATE, YORKS TELEX 54141

PANHARD CHOOSE NADELLA
WINNER MONTE CARLO RALLY 1961
NADELLA Needle Bearings
are fitted in the
• Differential Assembly
• Four-speed gearbox
• Torsion-bar Suspension
• Universal Joints
of the successful
PANHARD P.L. 17
PANHARD engineers choose
NADELLA Needle Thrust Bearings because
their high load capacity, slender proportions
and light weight reduce costs and simplify design.
No less than 35 NADELLA Bearings of various types
are used in their Panhard P.L. 17.
Not only Panhard, but CITROEN, RENAULT, PEUGEOT
and many other manufacturers of cars and
commercial vehicles specify NADELLA Bearings for
sustained performance and reliability.
first and foremost in needle bearings
NADELLA
Nadella Needle Bearing Company
Head Office: 133-137 Boulevard National, Rueil-Malmaison (S & O), France
Factories at Rueil-Malmaison and Vierzon, France, and Bienne, Switzerland
U.K. Technical Service and Sales Enquiries:
INSLEY INDUSTRIAL LIMITED, INSLEY HOUSE, 5 WINDMILL STREET, LONDON, W.1. Tel: LANgham 5425/6


LINE OF LEAST RESISTANCE
TYPE E WITH
TIMKEN TAPERED
ROLLER BEARINGS
For high speeds and heavy loads on Shafts 1 1/4″ to 5″.
TYPE SC
BALL BEARING
PLUMMER BLOCKS
For moderate loads; fully self-aligning and sealed for life. For Shafts up to 2 1/2″.
SPLIT
JOURNAL BEARINGS
(2-BOLT BASE)
A white-metalled bearing for moderate loads and speeds. Shaft diameters 3/4″ to 2″.
TYPE SC
FLANGE BEARINGS
Two types: four-bolt for Shaft diameters 1 1/16″ to 2 1/2″; two-bolt, 1 1/16″ to 1 7/16″.
TYPE SC
TAKE-UP BEARINGS
For conveyor, elevator and similar applications on Shafts 3/4″ to 2 3/16″.
SOLID
JOURNAL BEARINGS
(2-BOLT BASE)
A white-metalled, close-tolerance bearing for moderate loads and speeds. Shafts 3/4″ to 2″.
TYPE SC
CYLINDRICAL UNITS
Ideal where suitable holes can be provided in machine frame. For Shafts 3/4″ to 1 9/16″.
1861 1961
INTO A SECOND CENTURY OF PROGRESS
Fenner-Dodge
BEARINGS
ALL ARE ROBUST YET COMPACT AND WILL GIVE LONG SERVICE IN ARDUOUS CONDITIONS
Send for leaflet 251/19 (Series E) 252/20 (Series SC) or 253/20 (Journal) Bearings
J · H · FENNER & CO · LTD · HULL
LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH

Talk to Sykes about the

V10B Vertical Gear Generators

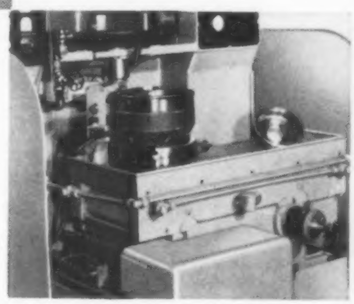
Whether you produce gears singly or in thousands there is a V10B Model designed specifically with your problems in mind. Incorporating many unique features for easy setting, simple maintenance and faster production times the V10B range of machines is years in advance of all other gear shapers.

SPURS · HELICALS · SPLINES · INTERNALS

SPROCKETS · RACKS · SEGMENTS

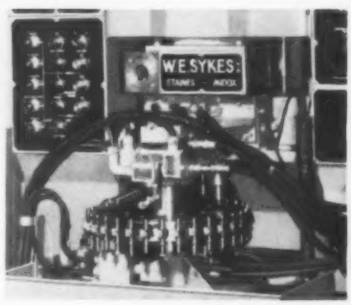
write for a copy of publication P18/60

STANDARD

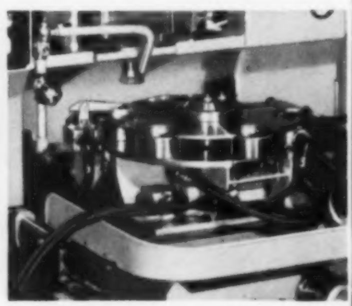


SEMI-AUTOMATIC

RACK CUTTING



SYKOMATIC



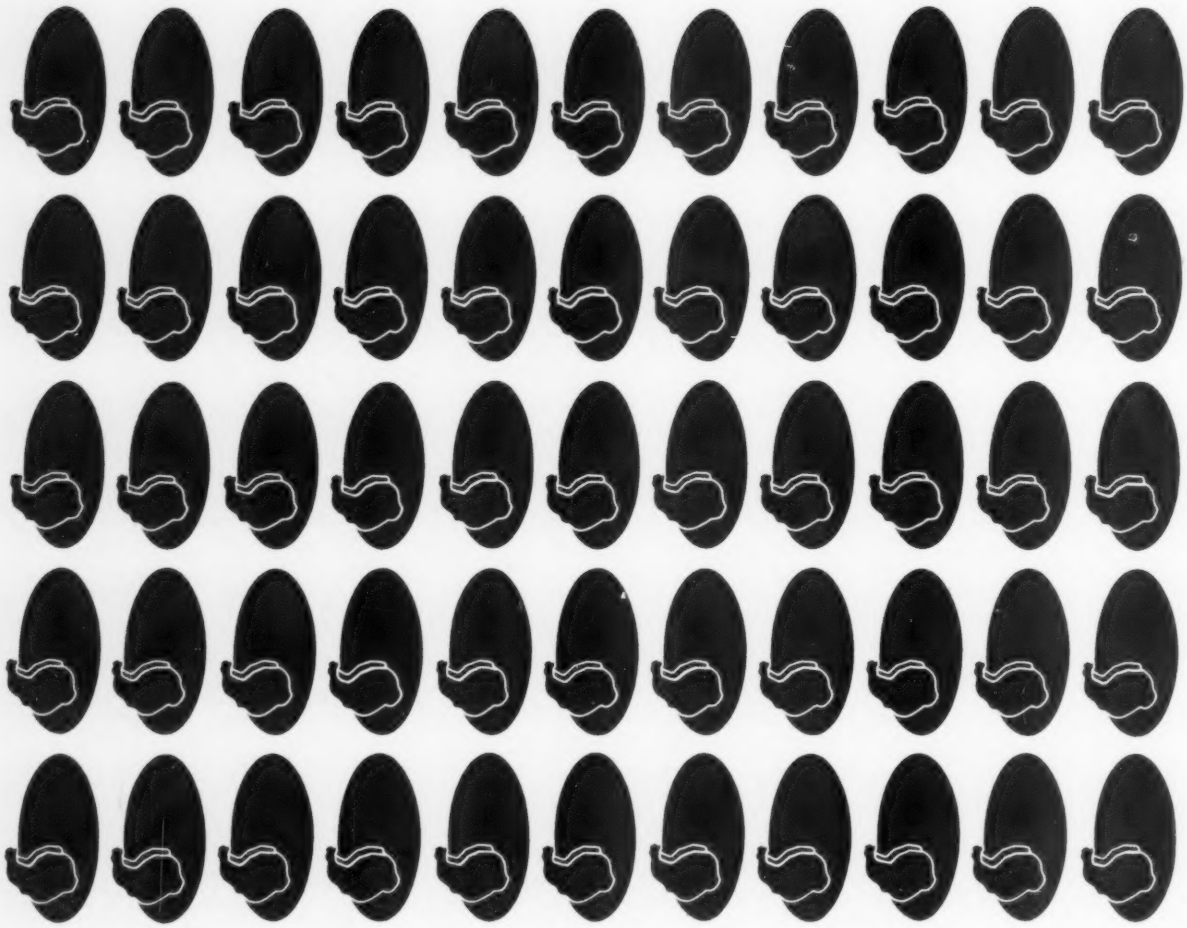
SYKOMATIC-INTERNAL

SYKES

W. E. SYKES LIMITED · STAINES · MIDDLESEX · ENGLAND

and associated companies:

Sykes Tool Corporation Ltd., Windsor, Ontario, Canada. Sykes Machine & Gear Corporation, Detroit, Michigan, U.S.A. W. E. Sykes Ltd., Mascot, Sydney, NSW, Australia.



NOVEMBER 1961 Volume 51 Number 11

AUTOMOBILE ENGINEER

CONTENTS

Published the second Wednesday in every month by ILIFFE PRODUCTION PUBLICATIONS LIMITED, Dorset House, Stamford Street, London, S.E.1
Telephone: Waterloo 3333 (65 lines). *Telegrams:* Sliderule London-SE1
The annual subscriptions inland and overseas are: £3 0s 0d including the special number; Canada and U.S.A. $8.50

BRANCH OFFICES
Coventry · 8-10 Corporation Street; *Telephone:* Coventry 25210 · Birmingham, King Edward House, New Street 2; *Telephone:* Midland 7191 · Manchester, 260 Deansgate 3; *Telephone:* Blackfriars 4412 and Deansgate 3595. Glasgow, 62 Buchanan Street, C.1; *Telephone:* Central 1265/6

Editor T. K. GARRETT *A.M.I.Mech.E., A.F.R.Ae.S.*
Editorial Staff F. C. SHEFFIELD (*Associate Editor*)
A. BAKER *B.Sc., A.M.I.Mech.E.* (*Assistant Editor*)
T. A. ATKINSON *G.I.Mech.E.*

Managing Director ARTHUR B. BOURNE *C.I.Mech.E.*

AUTOMOBILE ENGINEER

DESIGN · MATERIALS · PRODUCTION METHODS · WORKS METHODS

Road-Wheel Hub Lubrication

FOLLOWING the increasing adoption of disc brakes, fears have been expressed regarding the adequacy of the widely available, high-quality greases for the lubrication of the wheel hubs. It has been felt that, with disc type brakes, the combination of greater energy absorbed and the shorter path for conduction of heat from the friction faces to the hub will cause appreciably higher temperatures—by comparison with those of drum type—and therefore melting of the grease. Tests have proved that under severe conditions in some applications, local surface temperatures in the hub are liable to be in the order of 230 deg C.

Obviously, design measures, such as adequate provision for ventilation and, possibly, applying insulation material between the disc and the hub, can be used to keep the temperatures down. If such measures are not taken, the vehicle manufacturer may, of course, be faced with having to lubricate the hub bearing with special greases which are not readily available in all parts of the world — including, perhaps, the home market — and which, even if made available, would complicate distribution and storage in service and supply organizations.

Among the greases that have been suggested which are outside the range normally used for automotive applications are those containing a clay gelling agent. So far as actual lubrication properties are concerned, this clay additive has no significant merit for rolling element type bearings, although it can be used to advantage — for the avoidance of leakage — in plain bearings, especially in industrial machinery that operates at elevated temperatures.

It is highly desirable that the lubricants specified should be chosen from among those readily available at service stations. Field experience indicates that, among such greases, those containing lithium hydroxystearate perform satisfactorily in disc brake hubs. Admittedly, there can be problems with regard to stability, but these are not peculiar to this type of grease, nor are they difficult to overcome.

The best general purpose lubricants widely available today have been formulated as a result of extensive research, development and proving trials in the field, and therefore their lubrication, protective and other properties are well established: to depart too hastily from these lubricant specifications involves venturing into the unknown, and consequently is risky. This, it seems, is not always fully appreciated.

A point that has been frequently mentioned before, but which can never be over-emphasized, is that during vehicle prototype development, care should be taken that the evaluation of these existing materials is adequately and realistically carried out in close co-operation with the suppliers: completely independent evaluation, based on inadequate knowledge of all the relevant factors, can give misleading results.

On the assembly line, wheel hub bearings are, of course, generally filled by means of a grease loader gun, which inevitably entails completely filling the hub cavity. Although this practice is accepted in the interests of a high rate of production, it would be worth while devoting time and effort to the development of a better method of filling. The aim should be at leaving in the hub cavity between the bearings adequate space, not only for the accommodation of thermal expansion of the grease, but also because conduction of heat away from the bearings is impeded if the cavity is full.

Ideally, the bearings should be completely filled, between their inner and outer races, to ensure maximum protection, while the remainder of the interior of the hub and its cap should be only lightly smeared, mainly for the prevention of corrosion. However, when the currently employed grease loaders are used, the best that can be done is to leave the hub cap empty, so that it can accommodate surplus grease forced out of the hub cavity. This at least would avoid the throwing of grease over the wheel discs and rims at the outset of the service lives of the vehicles.

So far as servicing is concerned, the essentials for hub lubrication ought to be more widely disseminated. First, the hub and bearing assembly should be cleaned thoroughly with a solvent, but not with paraffin. Then the lubricant should be kneaded, preferably with a grease packer, into the space between the cages and races. Next the interior surfaces of the hub and cap, as well as the periphery of the stub axle, should be lightly smeared with the grease—as mentioned before, the hub cavity between the bearings must not be filled. Finally, experience indicates that it is still necessary to issue reminders that over-tightening of taper roller bearings can lead to rapid deterioration of the bearings.

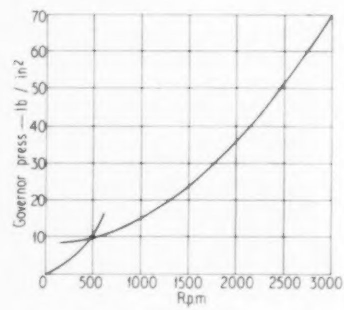
Borg-Warner Model 35 Transmission

Part II: Description and Functioning of the Governor, Valves and Other Components of the Hydraulic Control System

IN essence, the hydraulic control system of the transmission consists of two pumps, details of which were given in Part I of this article, a centrifugal type governor and a group of eight valves. As in all transmissions of this type, the control system effects gear changes under the combined influence of road speed and engine load. The variables used for this purpose are the output pressure from the governor and a pressure proportional to the throttle opening. Although the system is simpler than the majority, it does embody refinements that improve the quality of the gear shifts: regulating devices are used to ensure that the actuating pressures for the clutches and brake bands—as well as those applied to the shift valves to initiate the gear changes—are also related to both the speed and the load.

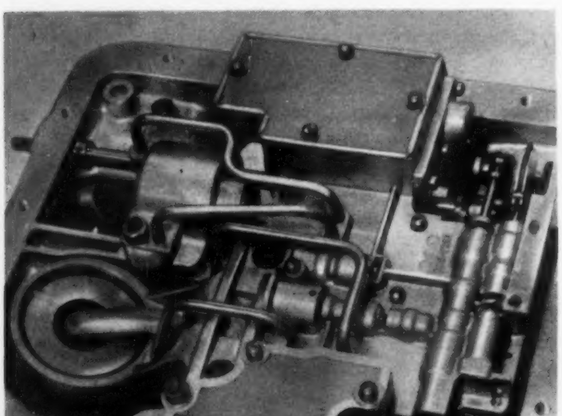
Both the hydraulic pumps draw their fluid from the sump through Intermit fine-mesh filters, which are housed in the valve body. Since the front hydraulic pump is driven from the input side of the torque converter, it supplies pressure whenever the engine is running. The rear pump, though, is driven by the output shaft of the transmission, and so is ineffective until the road speed reaches about 15 m.p.h. Consequently, the front pump supplies all the hydraulic needs when the vehicle is travelling below that speed or is stationary. When the rear pump becomes effective, it meets all requirements except that the converter and the lubrication system continue to be supplied by the front pump. This changeover, which is explained in greater detail later, is effected by two check valves.

One of the accompanying illustrations shows the components of the governor, the disposition of which was shown on the general arrangement drawing reproduced in Part I. The function of the governor is, of course, to provide a hydraulic pressure, known as the governor pressure, that varies with road speed. Although the operating principle of the governor is similar to that of the corresponding assembly in the Hydra-Matic 61-05 transmission, described in the January 1961 issue of *Automobile Engineer*, there is an interesting difference: only one governor valve is used on the Model 35 transmission, whereas the G.M.C. unit has two, one of which is most effective at low speeds and the other at higher speeds.



Graph of the governor pressure in relation to the speed of the output shaft; it shows the break point, where outward movement of the weight is checked by a stop in the body

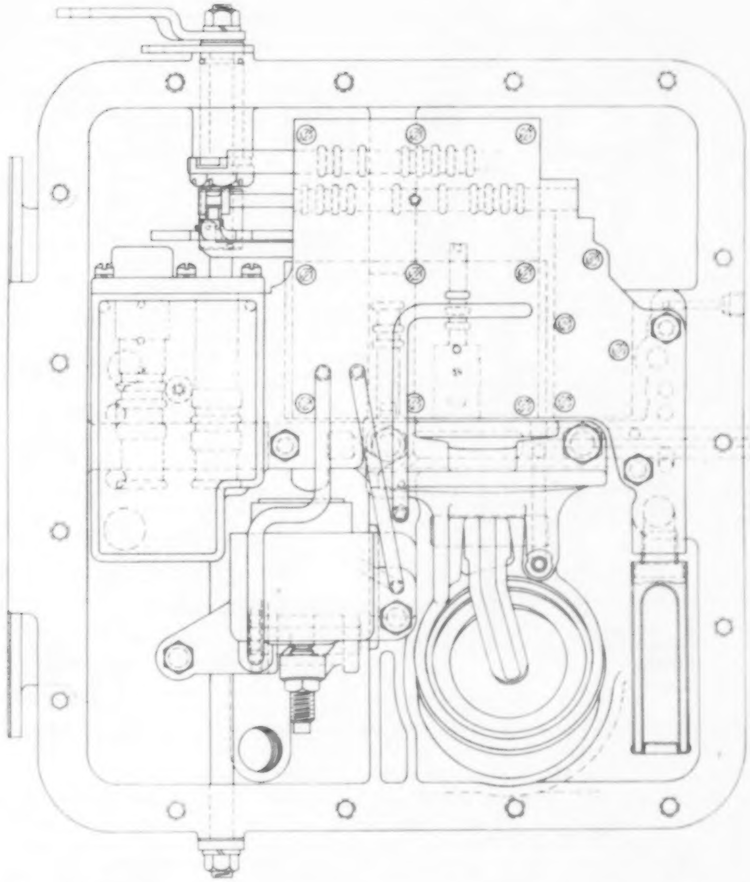
View of the Model 35 transmission from beneath, with the oil pan removed to disclose the valve body assembly, the servos and four of the pipes that connect the control valves with the clutches and servos



To endow the Borg-Warner governor with a similar two-phase regulation characteristic, a spring is interposed between the weight and the valve itself, which embraces the stem of the weight. Below a speed known as the *break point*, the inward force on the valve due to hydraulic pressure is opposed by the combined centrifugal forces on the valve and the weight, the second of these being transmitted by the spring. At break point, the weight has moved outward sufficiently to contact a stop in the housing, and so becomes ineffective; consequently, at all speeds above the break point, the valve is acted upon, in the outward direction, only by the spring thrust and its own centrifugal force.

Most of the hydraulic passages are internal, consisting of drilled holes in shafts, the casing and the central support member, as well as of annular spaces between coaxial components. To avoid unnecessary complication, however, there are eight separate oil pipes, four of which can be seen in the illustration of the unit viewed from beneath. Two of these visible pipes convey the applying and releasing fluid to and from the front servo, the third is for the fluid applying the rear clutch, and the fourth feeds the rear servo.

The control valves are housed in an assembly of aluminium alloy diecast bodies, bolted to the underside of the main



General arrangement of the underside of the transmission. At the top is the lever that actuates the manual valve, the stem of which protrudes from the housing. Immediately above the manual valve are the downshift and throttle valves, the first of which is coupled to the throttle linkage by a cable and cam arrangement. The rear servo can be seen, towards the right, near the bottom edge of the illustration, and the front servo unit adjoins it, further to the left

casing but separated from it by a steel plate. These valves are of three basic types—regulating, shuttle and manual. A regulating valve, of course, operates in equilibrium, hydraulic pressure being opposed by spring thrust; if unbalance occurs, the valve moves to uncover a feed port or an exhaust port, thus restoring the equilibrium. Each shuttle valve is of the two-position type, in which spring thrust is overcome by hydraulic pressure to cause the initial movement of the valve. These valves serve to direct the fluid for a particular purpose, or to provide an exhaust.

As on other automatic transmissions, the action of the control system is initiated by the manual valve, which is of the multi-land, spool type and is mechanically connected to the lever on the steering column. This valve, of course, selects the hydraulic circuits appropriate to each position of the lever. The other control valves have the following designations and will be described in the order given: primary and secondary regulator valves, throttle and downshift valves, which are regarded as a single unit, modulator valve and plunger, servo orifice control valve, 1 to 2 shift valve and plunger, and 2 to 3 shift valve and plunger.

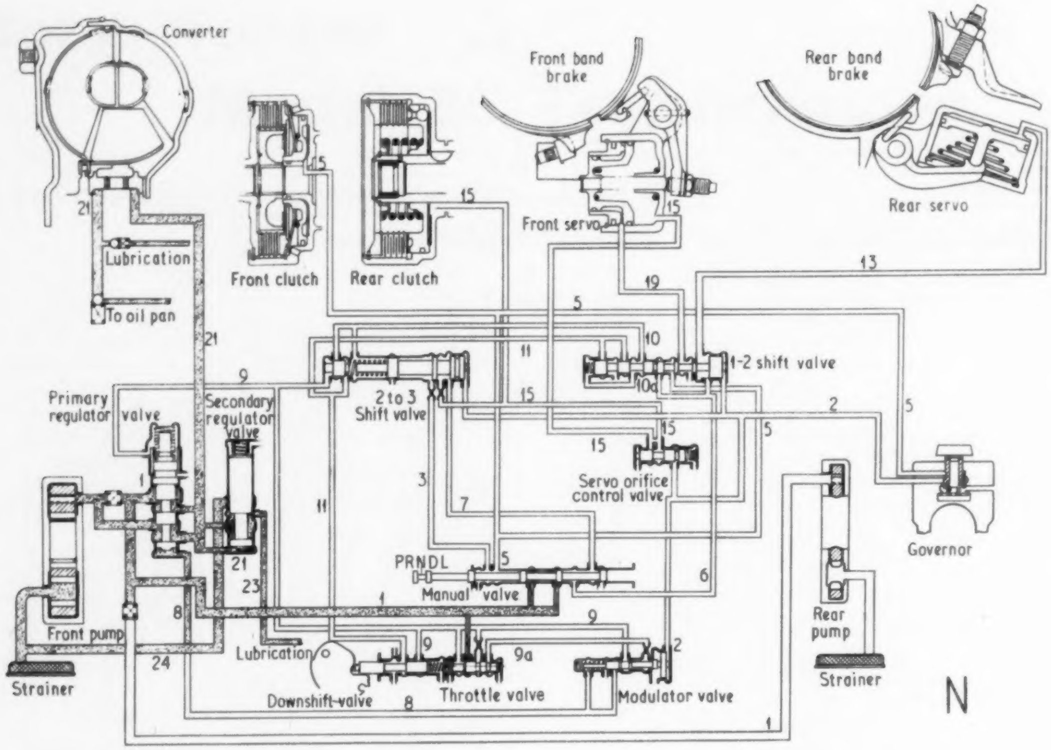
Pressurized fluid delivered by the pumps is regulated by the primary and secondary regulator valves. At low road speeds, the primary valve regulates the pressure of the front pump, but it also controls the rear pump pressure when—as the road speed rises—this exceeds the regulated pressure of the front pump. On the occurrence of this excess pressure, the check valve of the rear pump opens, allowing fluid to flow from the pump to the primary regulator valve; the pressure differential also causes the check valve of the front pump to close, with the result that its pressure is no longer applied to the primary regulator valve but is diverted straight through this to the secondary valve, and thence to the converter and the lubrication system.

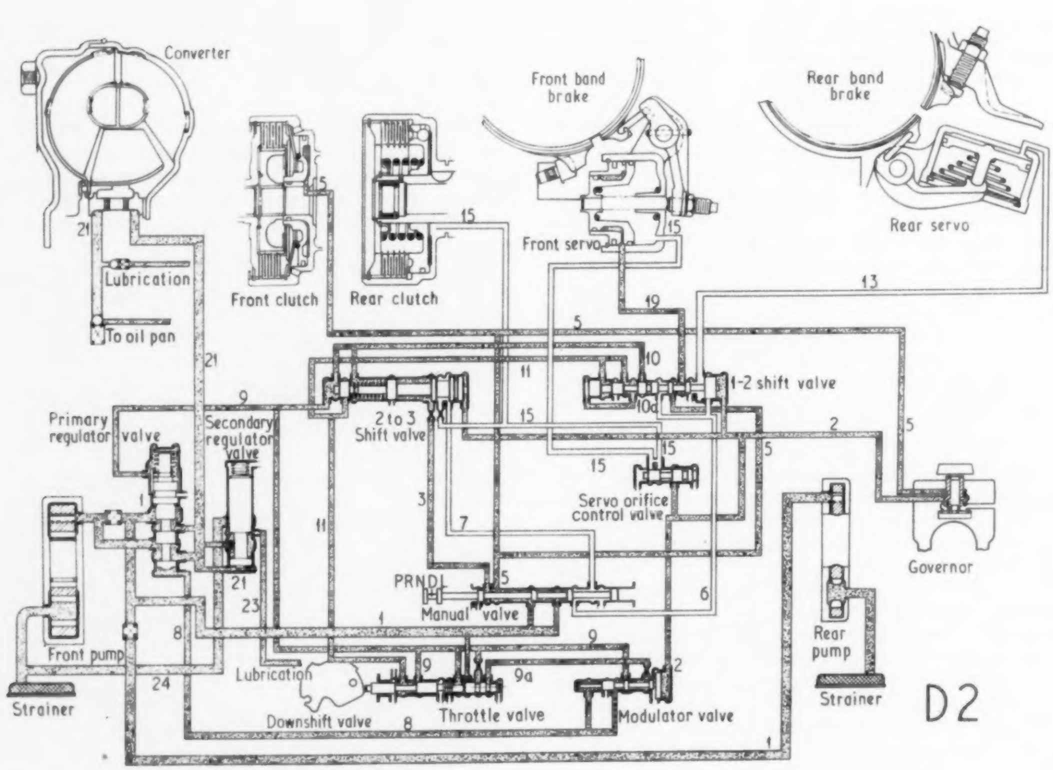
In the primary valve, the regulator spring and the throttle pressure—which, of course, is line pressure modified by the degree of throttle opening—are opposed by the combination of pump pressure and what is known as modulated throttle pressure, that is, the output pressure from the modulator valve, to which further reference will be made later. Owing to this modulated pressure, the resulting line pressure also varies with vehicle speed, thus providing the optimum value for actuating the clutches and servos in any operating condition. This line pressure is directed from the primary valve to the manual and throttle valves.

The secondary regulator valve controls the pressure delivered to the converter and the lubrication system by the front pump—or the rear pump if the front one is inoperative, as in a push start. If the force exerted by this pressure exceeds that of the spring, the valve moves to relieve it to the suction side of the pump. Owing to the lower regulating pressure of the secondary valve, losses in the front pump at high engine speeds are kept to a minimum.

It can be seen from the accompanying diagrammatic illustrations of the hydraulic system that the throttle and downshift valves are installed in tandem, and their pistons are separated by the throttle valve spring. Their purpose is to vary line pressure with accelerator pedal depression, thus ensuring that the torque transmitting capacity of the clutches and friction bands—and hence the quality of the gear shifts—is correctly related to the operating conditions. The downshift valve is therefore connected to the carburettor throttle linkage by a cable and cam arrangement.

Opposing the thrust of the throttle valve spring is that of the return spring at the remote end of the thottle valve, together with the throttle pressure; at low road speeds, this pressure acts on one land of the throttle valve, whereas at higher speeds, as will be explained shortly, it acts on two lands. The resulting delivery pressure, which is proportional to both the engine load and the vehicle speed, is the throttle pressure that has already been mentioned as being





TWO DIAGRAMS OF THE CONTROL SYSTEM, SHOWING THE CIRCUITS FOR NEUTRAL AND FOR SECOND GEAR IN "DRIVE"

Table 2.—DETAILS OF THE HYDRAULIC CIRCUITS IN THE CONTROL SYSTEM

Circuit number*	Name of pressure	From	To	Theoretical pressure range—lb/in²†	Remarks
1	Line pressure	front and rear pumps	primary regulator valve manual control valve throttle valve	57–208–98	
2	Governor pressure	governor	modulator valve 1 to 2 shift valve 2 to 3 shift valve	0–70	according to road speed
3	Directed line pressure	manual control valve	2 to 3 shift valve	57–208–98	in D
5	Directed line pressure	manual control valve	front clutch and governor feed 1 to 2 shift valve	57–208–98	in L and D
6	Directed line pressure	manual control valve	1 to 2 shift valve	57–208–98	in L, D, R and P
7	Directed line pressure	manual control valve	2 to 3 shift valve	57–208–98	in R and P
8	Modulated throttle pressure	modulator valve	primary regulator valve (piston end)	0–135–68	
9	Throttle pressure	throttle valve	modulator valve primary regulator valve (spring end) 2 to 3 shift valve plunger 2 to 3 shift valve	0–135–68	
9a	Throttle pressure controlled by modulator valve	modulator valve	throttle valve	0–135	doubles throttle pressure before cut-back and increases line pressure under part-throttle acceleration
10	Shift valve plunger pressure	2 to 3 shift valve plunger	2 to 3 shift valve 1 to 2 shift valve plunger	0–68	
10a	Shift valve plunger pressure	1 to 2 shift valve plunger	1 to 2 shift valve	0–68	in first gear only
11	Forced throttle pressure	downshift valve	1 to 2 shift valve 2 to 3 shift valve	135	
13	Line pressure	1 to 2 shift valve	rear servo apply	57–208–98	
15	Line pressure	2 to 3 shift valve	rear clutch and front servo release	57–208–98	front servo release through servo orifice or valve (see text)
19	Line pressure	1 to 2 shift valve	front servo apply	57–208–98	
21	Converter pressure	primary regulator valve	secondary regulator valve converter	18–25	
23	Lubrication pressure	secondary regulator valve	lubrication system	18–25	
24	Exhaust	secondary regulator valve	front pump suction	—	

**The non-consecutive numbering of the circuits is that used by the manufacturers, and is retained to avoid confusion*
†Where three theoretical pressures are quoted, the first is at idle, the second at forced throttle before cut-back, and the third at forced throttle after cut-back

applied to the spring end of the primary regulator valve.

This throttle pressure is also directed to the 2 to 3 shift plunger—referred to again later—which reduces its value by a fixed amount. The reduced pressure is, in turn, conveyed to the 2 to 3 and the 1 to 2 shift valves, for a regulating purpose to be explained in due course. When the accelerator pedal is fully depressed, though, the resultant full movement of the downshift valve causes the throttle pressure to be applied directly to the shift valves, that is, without regulation by the 2 to 3 plunger. Consequently, a downshift from third to second, or from second to first, occurs immediately the road speed falls below the pre-set maximum for the shift concerned.

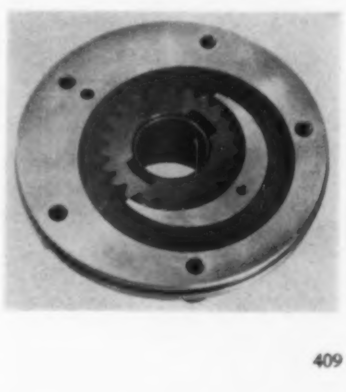
The modulator valve and its plunger are also in tandem, and the two have an inter-related action. Basically, the plunger portion is a spring-loaded regulator, which receives the output pressure from the throttle valve, and reduces it by a fixed amount. The resultant pressure is the modulated throttle pressure that has previously been mentioned in respect of the primary regulator valve. It is applied to the end of this valve remote from the spring, to vary the rate of alteration of the line pressure, which is already influenced by throttle pressure.

However, the action of the plunger is controlled by the modulator valve itself, which is of the shuttle type. In this valve, the modulated throttle pressure acting on one end is opposed by governor pressure at the other. As the governor pressure rises with road speed above a certain limit, the valve moves the plunger to the end of its housing, thereby compressing the spring, and so prevents it from regulating. This function is known as *cut-back*, and it obviously causes the modulated throttle pressure to become equal to the throttle pressure. The movement of the modulator valve also directs throttle pressure to a second land on the throttle valve, as previously stated. By this means, the high throttle and line pressures provided at the stalling condition of the converter are reduced when the vehicle is under way, to the lower values necessary for satisfactory gear shifting quality.

In the servo orifice control valve, which too is of the shuttle type, the governor pressure is opposed by a spring. This valve is inserted in the line that supplies fluid to, or exhausts it from, the release side of the servo for the front band. Since, for the second to third shift, the release of this servo is accompanied by the engagement of the rear clutch—and *vice-versa* for the third to second shift—the two units have a common line from the 2 to 3 shift valve until just short of the servo orifice control valve; at that point a divergence occurs and the other passage leads directly to the rear clutch.

The purpose of the orifice control valve is to provide a consistently high quality of shift in all conditions, by maintaining the correct timing relationship between the two functions just mentioned. At low speeds, the governor pressure is insufficient to move the valve. Consequently, when a shift is initiated, the fluid can flow directly through the valve, without having to pass through the 0·052 in. diameter orifice adjacent to it. As the road speed rises, however, the timing of the two functions becomes more critical; the governor pressure is then sufficient to move the control valve and so cause the fluid to be diverted through the orifice, which delays the actuation of the servo in relation to that of the clutch. On an upshift, this means that the servo is not released until the clutch is engaging, so accelera-

Both hydraulic pumps are of the internally meshing gear type; a crescent-shape member separates the intake and the delivery ports



tion of the engine, or *run-up,* does not occur. In the case of a downshift, on the other hand, the orifice prevents what is known as *tie-up,* the condition that occurs when the band is applied before the clutch is released.

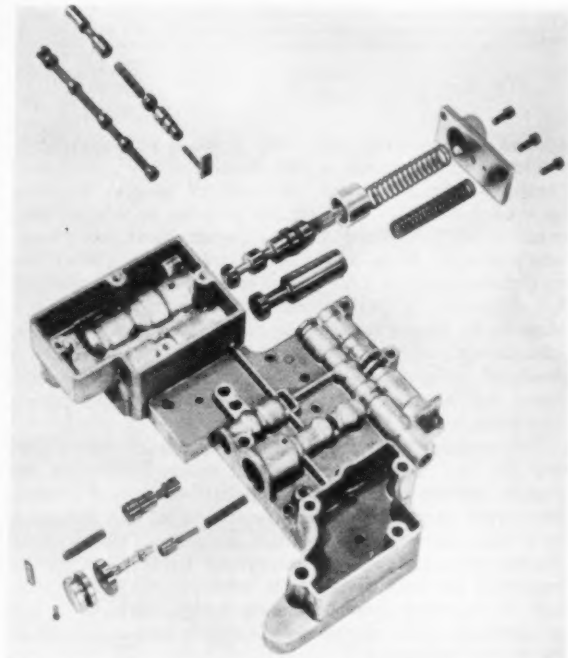
Both the 1 to 2 shift valve and its plunger are shuttle valves, mounted in tandem, and they operate in unison when the manual valve is in the "Drive" position. Their purpose is to direct fluid to apply the front servo piston, for a shift from first to second, or to release it for the second to first shift. Governor pressure is applied to the large end of the 1 to 2 shift valve, and is opposed by the reduced throttle pressure from the 2 to 3 shift plunger—mentioned in connection with the throttle and downshift valves—and the spring at the remote end of the 1 to 2 shift plunger, as well as by the hysteresis or bias effect of line pressure acting upon differential areas of the valve.

When the force exerted by governor pressure exceeds that of the spring plus the reduced throttle pressure, the valve and plunger move to the second gear position, and so line pressure is conveyed to apply the servo. This movement of the valve also cuts off the line pressure hysteresis. For a given throttle opening, the downshift from second to first therefore occurs at a lower road speed than does the corresponding upshift. If the force of governor pressure on the valve falls below that of the spring plus the reduced throttle pressure, the valve moves back to the first gear position and the passage from the applying side of the front servo is opened to exhaust.

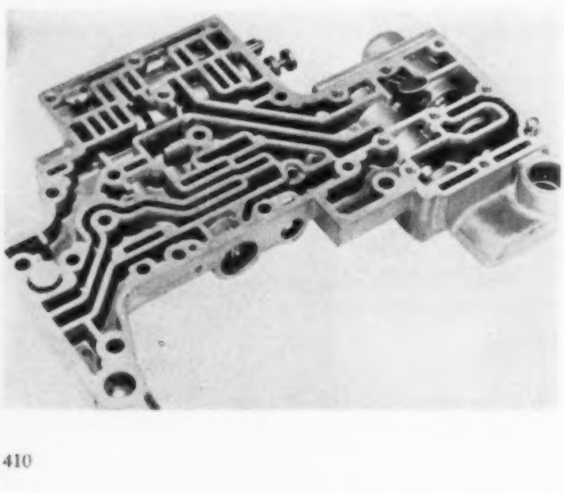
Should L be selected, however, line pressure from the manual valve is introduced between the 1 to 2 shift valve and the plunger, causing them to separate; this pressure renders the plunger inoperative, by compressing its spring. When the valve is in the second gear position, the governor pressure operating on the large end is opposed by line pressure acting on the small end. As soon as the force exerted by governor pressure becomes the smaller of the two, the valve moves to the first gear position; in so doing, it directs line pressure to the rear servo, which is applied in this condition of the transmission, as was mentioned in Part I. It also introduces line pressure to an additional area of the shift valve, thus opposing governor pressure and inhibiting an upshift from first to second. In the D position of the selector, the passage to this additional area is, of course, shut off.

For the changes between second and third gears, the appropriate action is initiated by the 2 to 3 shift valve and plunger, which also are installed in tandem. Since the plunger serves as a regulator to reduce by a fixed amount the throttle pressure acting on both the shift valves, as already stated, it is therefore inoperative when the pressure is less than that amount. The throttle pressure acting on one end of the plunger is opposed by this reduced throttle pressure and the force of the spring between the plunger and the valve. In addition, the reduced throttle pressure is applied to the valve itself and to the 1 to 2 shift valve plunger, to reduce their sensitivity and so to improve the relationship between the road speed and engine load at which gear shifts occur.

If the 2 to 3 shift valve is in its second gear position, and the throttle pressure is too low to be regulated by the plunger, the governor pressure acting on the large end of the valve is opposed by the spring and by line pressure hysteresis on differential areas of the valve. However, as soon as the plunger begins to regulate, owing to the rise in throttle pressure, the spring no longer exerts only its own force on the valve but relays to it the force exerted by the plunger. In this condition, the governor pressure is countered by line pressure hysteresis, by the reduced throttle pressure on the small end of the valve, and by the throttle pressure on the end of the plunger.



Right: The lower valve body and its valves and other components. Above the body are the manual, downshift and throttle valves; to its right are the primary and secondary regulator valves; and low on the left are the servo orifice control and modulator valves. Below: This view, from above, of the lower valve body, reveals the complexity of the diecasting design necessitated by the provision of the fluid passages



When the force due to the governor pressure overcomes the resistance, the valve moves to the third gear position, and directs line pressure through the common line to the rear clutch and the release side of the front servo piston. Because this side has a larger area than has the applying side, which is still subjected to pressure from the 1 to 2 shift valve, the band is released. The movement of the valve cuts off the line pressure hysteresis and also displaces the plunger to the end of its bore, thus preventing it from regulating. As in the case of the 1 to 2 shift valve, the line pressure hysteresis causes upshifts from second to third

to occur at a higher speed than the downshifts, for a given throttle opening.

When the transmission is in third gear, movement of the manual valve from the D to the L position results in the exhausting of the line pressure that was previously directed to the 2 to 3 shift valve and thence to the rear clutch and the release side of the front servo. It follows that the rear clutch is released and the front band applied, so a downshift to second gear occurs immediately, without movement of the 2 to 3 shift valve.

To facilitate understanding of the functioning of the control system, two typical hydraulic diagrams are reproduced, together with a table outlining the nature of each of the circuits, which are numbered for ease of reference. However, the following summary of the basic conditions in each selector position may be of value. In the L position, line pressure is directed from the manual valve to the front clutch and the governor, but not to the 2 to 3 shift valve; therefore, changes from second to third cannot occur: the locking of the 1 to 2 shift valve in first gear has already been mentioned. For the D range, on the other hand, line pressure is applied to the two shift valves, as well as to the front clutch and the governor.

In neutral, both clutches and both servos are open to exhaust; hence the gear train is disconnected from the torque converter, and no engine power is transmitted. Movement of the manual valve to the R position directs line pressure by way of the 1 to 2 shift valve to the rear servo, and through the 2 to 3 shift valve to the rear clutch. Since no pressure is applied to the governor, and line pressure is balanced on the shift valves, no upshifts can occur. Finally, the selection of P causes the mechanical engagement of the parking pawl. No fluid is directed to either clutch, so the gear train is disconnected from the converter. Although line pressure is applied to the rear servo, this is incidental and arises merely because of the necessity of arranging the porting to suit the other positions of the manual valve.

The components of the governor. In the left-hand lower corner can be seen the weight, of mushroom form, and on the other side of the housing is the valve, which embraces the stem portion of the weight

Since Part I of this article went to press, it has been announced that the Warner Gear Division of the Borg-Warner Corporation in the U.S.A. is now also producing this transmission, for the American Motors Corporation. As would be expected, the development work in connection with this application was carried out in America, where the present rate of output is stated to be 1,000 units a day.

Concluded

DPA Injection Pumps in France

SOON after production of the DPA distributor type fuel injection pump began in 1956, at the Rochester factory of C.A.V. Ltd, it became obvious that this unit had a considerable potential market in Europe as well as in Great Britain. Since this market could clearly be more effectively attacked from France than from the United Kingdom, a new French company, Roto Diesel S.A, was founded in October 1959 to produce under licence not only the DPA pump but its associated nozzles and nozzle holders, and the FS fuel filter. The capital of this company is held jointly by C.A.V. Ltd. and the French D.B.A. group, the initials of which stand for three well-established companies—Ducellier, Bendix and Air Equipement.

During 1960, a factory was built for Roto Diesel at Blois, on the River Loire, about 103 miles from Paris and 37 miles from Orléans. The factory itself has a floor space of 86,000 ft^2 and occupies a 12 acre site, so there is plenty of room for expansion. Although not yet fully equipped, it has been in operation for several months and was officially opened in September. At present, the total establishment is 520, including 60 inspectors, but ultimately this will be considerably increased. When the installational work is completed, there will be about 200 machine tools in the factory, all of them new and of the latest types. Comprehensive facilities have been provided for heat treatment, inspection and testing, and—to ensure the highest accuracy of production and measurement—certain sections of the building are air conditioned, with very close control of the temperature. The key personnel and foremen have undergone training at the British factory for periods of up to 18 months, to ensure their thorough conversance with the work.

As would be expected, most of the components and assemblies were originally imported by Roto Diesel from Britain. Already, however, the proportion of French manufacture in the pumps is overtaking the C.A.V. contribution, and it is expected that, by the end of this year, the objective of 100 per cent French content will have been gained. From that stage, production will be built up to the present target of 100,000 units a year.

Initially, the pumps are being fitted to the five Perkins engines manufactured under licence in France. These engines are installed in certain Citroën, Hotchkiss and Renault commercial vehicles, and in Renault and French-made Massey Ferguson tractors, as well as several makes of combine harvester. However, once production reaches an adequate level, other Continental makers of diesel engines will be encouraged to adopt the pump.

Lectures on Patents

A COURSE of lectures on "Patents and Industrial Design Protection" has been arranged by Sir John Cass College, Jewry Street, Aldgate, London, E.C.3. There will be eight 1½ hour lectures, with periods for questions and discussion, and they will be held on Thursdays at 6 p.m, beginning on the 18th January 1962. The fee for the course is £1, and application for the enrolment form should be made, prior to the opening date, to the Secretary, at the above address.

ENGINE TEMPERATURES AND PRESSURES

Influence of Operating Variables on Peak Conditions in the Otto Cycle

S. E. BONAMY,* B.E., M.Sc., Ph.D., A.M.I.Mech.E., A.M.I.E.(Aust.)

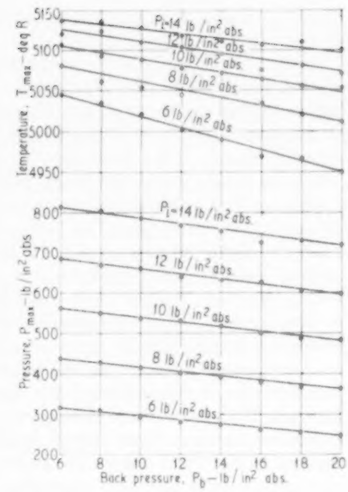
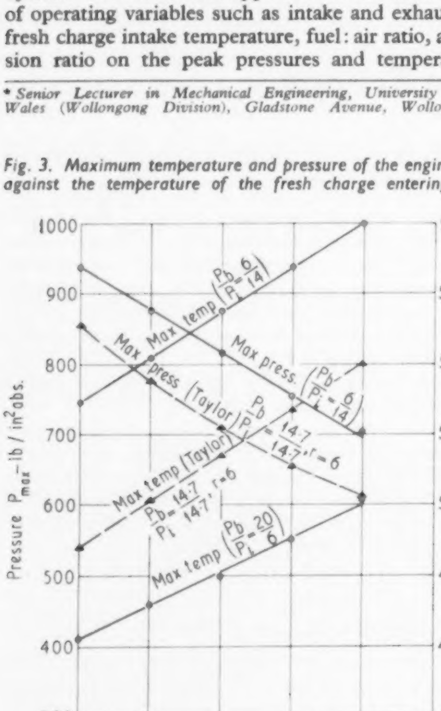


Fig. 1. These curves show variation of maximum temperature and pressure with manifold pressure

OF the temperatures and pressures occurring in an internal combustion engine, those that are likely to be of most interest to the designer or research worker occur immediately after combustion: that is, they are the peak values. The most satisfactory way of determining these temperatures and pressures for theoretical engine cycles is by use of thermodynamic charts such as those prepared by Hottel, Williams and Satterfield.[1] These charts take into consideration factors such as variations of specific heat, dissociation and residual gases from the previous cycle. In this article, a detailed analysis of the charts is given together with worked examples for throttled, unthrottled and supercharged engine cycles. The charts are applied here to examine the effects of operating variables such as intake and exhaust pressures, fresh charge intake temperature, fuel: air ratio, and compression ratio on the peak pressures and temperatures in an Otto cycle engine. In cases where the exhaust pressure is less than the intake pressure, cycles are analysed as for the supercharged case, the method described by Bonamy[2] being used in preference to that by Hottel *et al.*

* *Senior Lecturer in Mechanical Engineering, University of New South Wales (Wollongong Division), Gladstone Avenue, Wollongong, N.S.W.*

Fig. 3. Maximum temperature and pressure of the engine cycle plotted against the temperature of the fresh charge entering the cylinder



Cycles analysed

In the first series of cycles analysed, the effects of varying intake and exhaust pressures on peak conditions were examined. The compression ratio was considered constant, at 6·5 : 1, the fuel : air ratio as 1·2 times that required for the stoichiometric combustion, and the incoming fresh charge temperature as 600 deg R. These were actual average values experienced during tests on a 60 h.p. multi-cylinder petrol engine, at 2,500 r.p.m. For these constant conditions, back pressures P_b ranging from 6 lb/in² abs. to 20 lb/in² abs, in 2 lb increments, were chosen for intake pressures P_i of 6, 8, 10, 12 and 14 lb/in² abs, making a total of 40 cycles analysed. The variations occurring in mean effective pressure and thermal efficiency under these conditions have been discussed previously by Bonamy and Upfold.[3]

With the second series of cycles, an examination was made of the effects of fresh charge temperature, compression ratio and fuel: air ratio on peak temperature and pressure conditions. For each of the extreme limits of manifold pressure ratio, $P_b/P_i = 20/6$ and $P_b/P_i = 6/14$, considered in the first series, and using the same relevant constants for compression ratio, fuel: air ratio and fresh charge temperature, cycles were calculated for:

I Fresh charge temperatures ranging from 500 deg R to 700 deg R, in 50 deg increments.

II Compression ratios ranging from 5·5 : 1 to 9·5 : 1, in unit increments.

III Ratios of fuel : air compared with the stoichiometric value of 0·8, 0·9, 1·0, 1·1, 1·2 and 1·5 : 1, these corresponding with those indicated by the thermodynamic charts available.

The results of the analyses are plotted in Figs. 1 to 5 and comparisons are made, where possible, with similar curves obtained by Goodenough and Baker[4] and with curves from the work by Hershey, Eberhardt and Hottel[5] as plotted by Taylor.[6] Goodenough and Baker's curves were obtained from calculations of a number of Otto cycles for various fuel : air ratios and compression ratios based on data available on dissociation equilibrium constants and specific heats. Although the data used by these authors have been subject to much revision, the trends shown by their curves are still found to be valid. Hershey *et al*[5] calculated a number of Otto cycles similar to those used in the present work, but for only one intake pressure of 14·7 lb/in² abs, separate

charts being used for the compression and expansion processes. The compression charts were plotted for thermodynamic properties of an air-octane mixture containing a fixed quantity of residual gases prior to combustion, and the expansion charts were plotted for the properties of the equilibrium mixture after combustion. These expansion, or burned mixture, charts were later plotted with greater accuracy, and the various compression charts were replaced by a modified air chart, in which variations in the quantity of residual gases are taken into account. These latter charts are used in the present analyses.

Intake and exhaust pressures

In Fig. 1, maximum cycle temperatures and pressures are plotted against exhaust back pressure for the various intake pressures. For all values of intake pressure, the maximum temperature is seen to decrease linearly with increasing back pressure, the rate of decrease being greater at the lower intake pressures. This is caused by an increase, with back pressure, in the weight fraction of residual gases present, this increase being more predominant at the lower intake pressures.[3] The presence of residual gases increases the temperature of the charge at the beginning of compression and, therefore, for a fixed compression ratio, at the beginning of combustion; but the correspondingly reduced weight of fresh charge available for combustion has a predominating influence, causing a reduction in maximum cycle temperature.

Fig. 2. The two curves on the left represent the variation of overall pressure ratio with manifold pressure ratio

Fig. 4. Below, right: Peak temperatures and pressures plotted against compression ratio, for the two extreme values of manifold pressure ratio

The maximum cycle temperature varies from 5,140 deg R to 5,097 deg R at an intake pressure of 14 lb/in² abs, and from 5,045 deg R to 4,950 deg R at an intake pressure of 6 lb/in² abs, for an increase in back pressure from 6 lb/in² abs. to 20 lb/in² abs. This represents a decrease of 3 deg F and of 7·5 deg F per lb increase in back pressure, for intake pressures of 15 lb/in² abs. and 6 lb/in² abs. respectively.

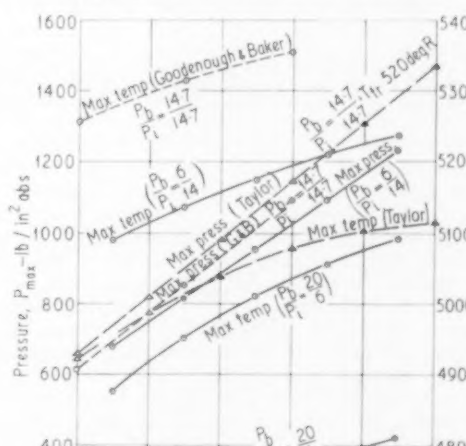
Curves relating maximum cycle pressure and back pressure for the various intake pressures appear as a series of almost parallel straight lines. The steady decrease in maximum pressure with increased back pressure is to be expected, since there is a corresponding decrease in maximum temperature. For all values of intake pressure used, the maximum cycle pressure is reduced by an average value of 6 lb/in² per lb increase in back pressure. A change in intake pressure, however, is seen to have a far more serious effect on maximum pressure: an increase in intake pressure from 6 lb/in² abs. to 14 lb/in² abs. raises the maximum pressure linearly by approximately 600 lb/in² for all values of back pressure, that is, by 75 lb/in² per lb increase in intake pressure. This is due partly to the increase in pressure at the end of compression when compressing from a higher intake pressure but mainly by the reduced weight fraction of residual gases, which allow an increase in the weight of fresh charge available for combustion. The weight fraction of residual gases has been found to be inversely proportional to the intake pressure[3].

In Fig. 2, a dimensionless plot of P_{max}/P_i against P_b/P_i is compared with a curve by Taylor.[6] A similar trend is realized, but it should be noted that Taylor's curve, although plotted for the same initial temperature and almost the same fuel : air ratio, is for a compression ratio of 6 : 1 and is obtained from charts which have been superseded by those used in the present work. Taylor[6] has plotted also a curve of maximum temperature against P_b/P_i, obtained by using only one value of intake pressure and a range of values of back pressure. An examination of Fig. 1, for a range of intake pressures, will reveal that such a single curve could not be drawn to relate these quantities.

Fresh charge temperature

In Fig. 3, peak cycle temperatures and pressures are plotted against fresh charge temperature, for each of the extreme values of manifold pressure ratio used. The peak temperature is seen to increase linearly with fresh charge temperature, the rate of increase being slightly greater at the lower manifold pressure ratio. Also, the maximum temperature changes from 5,073 deg R to 5,200 deg R, and from 4,905 deg R to 5,000 deg R, at the lower and higher manifold pressure ratios respectively, for a change in fresh charge temperature from 500 deg R to 700 deg R. This represents an average increase in maximum temperature of 5·6 deg F per 10 deg F rise in fresh charge temperature, which is equivalent to a peak temperature rise of approximately one half that of the fresh charge temperature, irrespective of manifold pressure ratio. It might be expected, on first sight, that the maximum temperature should increase by at least an amount equal to the rise in fresh charge temperature, but the presence of residual gases, once again, offsets the increase. The larger specific volume of the fresh charge at the higher intake temperatures reduces the weight fraction of fresh charge admitted per cycle and therefore increases the weight fraction of the residual gases in the combustion chamber.

Maximum cycle pressure is seen to decrease linearly as



fresh charge temperature increases, the reduction being greater at the lower manifold pressure ratio. The maximum pressure changes from 940 lb/in² abs. to 698 lb/in² abs. and from 280 lb/in² abs. to 215 lb/in² abs, at the lower and higher manifold pressure ratios respectively, for a change in intake temperature from 500 deg R to 700 deg R. This represents reductions of 25·5 per cent and 23·2 per cent for a 200 deg F increase in fresh charge temperature. Hence the maximum cycle pressure is reduced by approximately 0·12 per cent per deg F increase in fresh charge temperature, irrespective of manifold pressure ratio. This strange phenomena of reduced maximum cycle pressure with increased fresh charge temperature, is caused by the increase in specific volume at intake, which increases the specific volume and, therefore, reduces the pressure at the end of combustion.

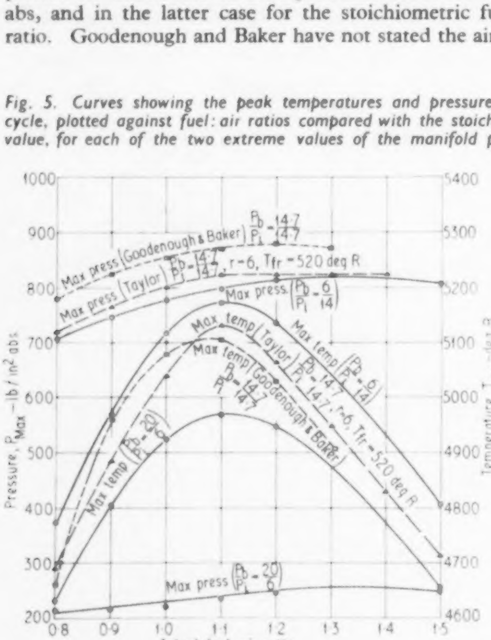
Curves of maximum cycle temperature and pressure plotted against intake temperature, reproduced from Taylor,[6] show the same general trend as the present curves, but can hardly be used for comparison since they are plotted for a compression ratio of 6 : 1 and intake and exhaust pressures each of 14·7 lb/in² abs.

Compression ratio

In Fig. 4, peak temperatures and pressures are plotted against compression ratio, for the two extreme values of manifold pressure ratio. Maximum cycle temperature is found to increase with compression ratio, the rate of rise being slightly greater at the higher manifold pressure ratio. An increase from 5,097 deg R to 5,237 deg R, and from 4,875 deg R to 5,092 deg R is realized at the lower and higher manifold pressure ratios respectively, for a rise in compression ratio from 5·5 to 9·5 : 1. The corresponding increases in maximum pressure are from 680 lb/in² abs. to 1,230 lb/in² abs, and from 190 lb/in² abs. to 420 lb/in² abs: they are caused partly by the raised compression pressure and temperature and partly by the expulsion of more residual gases as the weight fraction of fresh charge available for combustion becomes greater.

Curves reproduced from Taylor and from Goodenough and Baker's work show the same general trend, but can hardly be used for comparison: in both cases the curves are plotted for intake and exhaust pressures each of 14·7 lb/in² abs, and in the latter case for the stoichiometric fuel : air ratio. Goodenough and Baker have not stated the air intake

Fig. 5. Curves showing the peak temperatures and pressures of the cycle, plotted against fuel: air ratios compared with the stoichiometric value, for each of the two extreme values of the manifold pressures



temperature used, but Taylor's curves are based on intake temperature of 520 deg R, compared with 600 deg R in the work that is the subject of this article.

Fuel : air ratio

A plot of peak cycle temperatures and pressures against fuel : air ratios compared with the stoichiometric value, for each of the extreme manifold pressure ratios, is given in Fig. 5. Curves by Goodenough and Baker and by Taylor, added for comparison, show a general trend the same as these, even though they are plotted for intake and exhaust pressures each of 14·7 lb/in² abs. and, in the latter case, for a compression ratio of 6 : 1 and a fresh charge temperature of 520 deg R. Goodenough and Baker have not stated the intake temperature used as the basis for computing their curves.

As the mixture strength is increased beyond the stoichiometric value, more of the uncombined oxygen is used and this tends to release more heat during combustion and increase the maximum temperature. Opposing this, however, is the tendency to burn more of the oxygen to carbon monoxide instead of to carbon dioxide and, therefore, reduce the heat liberated. Hence, as shown in Fig. 5, the maximum cycle temperature at first increases and then decreases with increasing mixture strength, a peak value being reached at a fuel : air ratio of 1·1 times that required for complete combustion.

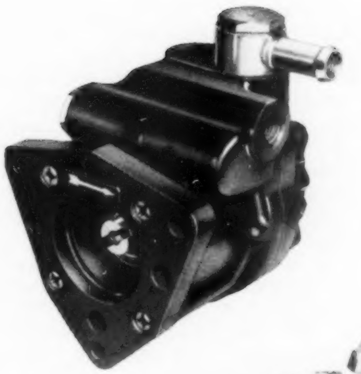
The maximum cycle pressure, on the other hand, is seen to reach a peak value at a fuel : air ratio of 1·3 times the stoichiometric value. Apparently the reason for this peak being reached at a richer mixture strength than for the maximum temperature is as follows. The combustion process is considered to take place at constant volume and the pressure, therefore, is proportional to the number of molecules and the temperature. As the mixture strength is increased above the stoichiometric value, the formation of more carbon monoxide in place of carbon dioxide increases the number of molecules in the gas and therefore tends to increase its pressure. This tendency for pressure to increase overcomes, for a time after the maximum temperature is reached, the adverse effect of falling temperature and causes the peak pressure to be reached at a greater mixture strength.

References

1. H. C. HOTTEL, G. C. WILLIAMS and C. N. SATTERFIELD: 1949, "Thermodynamic Charts for Combustion Processes", Parts 1 and 2, *John Wiley*, New York
2. S. E. BONAMY: "Solution of Supercharged Engine Cycles", *Automobile Engineer*, Oct, 1959
3. S. E. BONAMY and R. W. UPFOLD: "Exhaust Back Pressure", *Automobile Engineer*, Dec, 1959
4. G. A. GOODENOUGH and J. B. BAKER: "A Thermoydnamic Analysis of Internal Combustion Engine Cycles", *University of Illinois Eng. Exp. Sta. Bull*, 160, 1927
5. R. L. HERSHEY, J. E. EBERHARDT and H. C. HOTTEL: "Thermodynamic Properties of the Working Fluid in Internal Combustion Engines", *S.A.E. Journal*, Oct, 1936
6. C. F. TAYLOR: "The Internal Combustion Engine in Theory and Practice", *M.I.T. Technology Press and J. Wiley*, 1960.

N.E.L. Annual Report

A PUBLICATION recently received is the National Engineering Laboratory's annual report for 1960. It includes sections on: the direct industrial application of principles established at the N.E.L.; background research and new facilities for research and sponsored investigations; new measuring instruments and techniques; and examples of sponsored work. Because of the diversity of the Laboratory's activities, it is not practicable to summarize the report, but mention should be made of the successful application to machine tools of hydrostatic power transmissions designed at the N.E.L. The report is available, price 5s, from any branch of Her Majesty's Stationery Office, or booksellers.



Hobourn-Eaton Roller Type Pump

Details of an Unusual and Efficient Hydraulic Unit, Intended for Power-Assisted Steering and Other Applications

The pump shown above is for direct drive, and its reservoir is mounted remotely. In contrast, the other unit is of the belt driven type, and the reservoir is carried directly on its body

ALTHOUGH mention of the Hobourn-Eaton roller type pump was made in *Automobile Engineer* as long ago as May 1960, in an article on the Hydrosteer integral power-assisted steering unit, the publication of a detailed description has been delayed pending notification, from the manufacturers, of its going into normal production. It now forms part of the power-assisted steering installation on certain Humber, Jaguar and Rover cars.

In design, the roller type pump is entirely different from the company's familiar eccentric-lobe units: displacement is effected by a ring of rollers axially disposed around the rotor, and operating within a cam ring. The American Eaton company was responsible for the original design but, because the models manufactured in the U.S.A. were larger than those required for this country, a smaller series was designed and developed at the Strood, Kent, factory of the Hobourn-Eaton Manufacturing Co. Ltd.

In the interest of standardization, the three sizes of pump are of a common diameter, but each has a different length of roller. Several driving and mounting arrangements are available, and the versatility is enhanced by the adoption of alternative mountings for the hydraulic reservoir, either on the pump or adjacent to it. The normal maximum delivery pressure is 1,000 lb/in^2, by comparison with the 750 lb/in^2 of the eccentric lobe type, but pressures of up to 1,200 lb/in^2 are permissible in certain circumstances. Various fluids can be handled, the only proviso being that the lubricating properties should be adequate and the viscosity not too high.

The main advantages of the roller pump over the earlier design are its higher volumetric efficiency and the smaller variations in its noise level, which in any case is low, under normal operating conditions. This more consistently quiet operation is attributable largely to two features made possible by the use of the roller and cam layout. One is what is known as over-filling and the other as check-valve action, and both will be described in detail later in this article. Flow control, essential for power-assisted steering and certain other applications, is a standard feature, but can be omitted if not required.

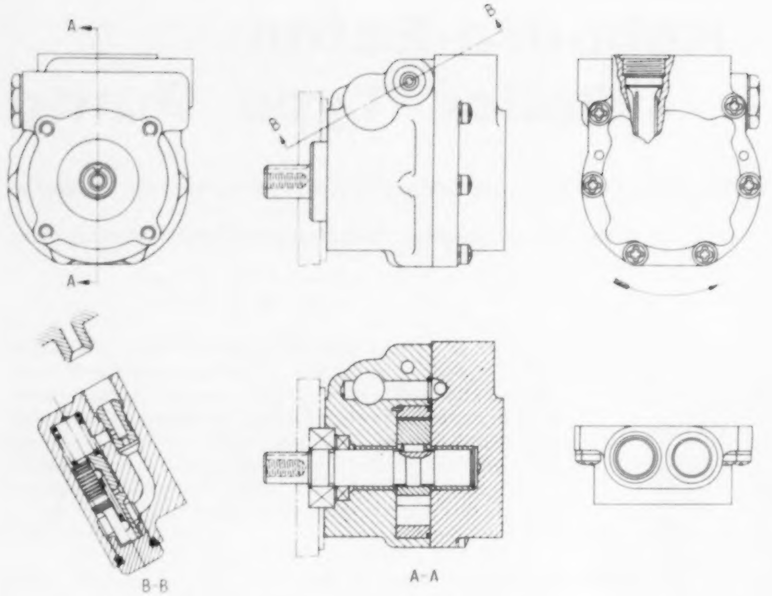
Design and construction

The pump comprises two main assemblies, the casing and the rotor. Normally, the casing assembly consists of four components: they are the body, its end plate and end cover—respectively at the drive and the other end of the assembly—and the actuating cam. In some applications, however, there is a fifth, as will be explained in the next paragraph. The rotor unit comprises the driving shaft, the roller carrier and the rollers themselves. An indication of the compactness of the pump can be gained from the typical overall dimensions of 4·1 in long by 3·7 in wide by 4·2 in deep.

According to individual requirements, the pump can be driven directly—in the Jaguar and Rover installations, from the end of the generator shaft—or by means of a belt, as in the Humber installation. Where direct drive is specified, the attachment flange, which can be of any reasonable shape, is embodied in the end plate of the casing assembly. In the case of belt drive, however, the flange can be at either end of the pump, and for this reason the ends are of similar shape. If the flange is at the drive end, it is again integral with the end plate, but if it is at the remote end it is an additional item: a spigot is machined in the end cover to take it, and extra holes are tapped for the retaining screws. Through-drive can readily be incorporated in a belt driven pump by extending the drive shaft through the end cover, which otherwise has a blind bore. Use is made of the through drive feature should reversed rotation be necessary in a particular application: the pump is then merely driven from the opposite end.

The body and end cover are shell-moulded iron castings. It was found in the early stages of development that shell-moulding gave considerably better control of the positioning and form of the porting and other internal passages than did sand casting, thereby making for higher efficiency and greater consistency of performance. The feed from the reservoir is into the end cover, and the delivery passage is in the body, which also houses the combined flow-control and relief valve. For greater clarity, the design of the porting and this valve will be described later. The cam and the rotor assembly are housed in a counterbore in the body, adjacent to the joint face with the end cover.

A case-hardening nickel steel is employed for the shaft, which has a diameter of $\frac{3}{4}$ in over most of its length. There is an eccentricity of $\frac{5}{32}$ in between the axis of the shaft and that of the counterbore just mentioned. Two different bearing layouts are employed, according to whether the pump is driven directly or by means of a belt. In both cases,



Reproduction of the general arrangement drawing of the Hobourn-Eaton roller type hydraulic pump. The rotor shaft is carried in two lead-bronze bushes and, in the case of a belt driven unit, a ball bearing at the drive end. A key of cylindrical form transmits the drive from the shaft, in which it is located, to the roller carrier. Section B-B shows the flow-control valve

though, the shaft is carried in two lead-bronze bushes of the wrapped type, one of which is housed in the body and the other in the end cover. If the pump is directly driven, a sintered bronze thrust pad is installed in the blind housing of the second of these bearings, beyond the undriven end of the shaft. Outboard of the first bearing is a lip type oil seal, which is pressed into a counterbore in the body. The end of the shaft is slotted to accept the tongue of an Oldham type coupling of bonded, metal and rubber construction.

If the pump is belt driven, however, the thrust pad is deleted and there is an additional, ball bearing at the drive end of the shaft to withstand the pull of the belt. The inner race of this bearing is pressed on to the shaft, where it is clamped between a shoulder and the driving pulley. Counterbores in the body and the end plate accommodate the outer race, which is clamped between these two components when the retaining screws are tightened. With this arrangement, the oil seal is installed immediately inboard of the ball bearing. In the case of a through-drive unit, of course, a second oil seal is necessary: it is carried in the end cover, outboard of the plain bearing. Surplus oil seeping through the plain bearings is led through internal passages back to the intake side of the pump.

On the shaft is mounted the roller carrier, which has six slots of special form to guide the rollers. The slots taper in width towards their bases, but their axes, instead of being radial, have an appreciable trailing angle. This form has been found more efficient than others in providing the necessary control over the radial movement of the rollers; the purpose of this movement will be explained later. In the standard pumps, the carriers are made of a carbon-silicon-manganese steel, which is heat treated to a moderate hardness before the slots are generated by hobbing.

An unusual method of mounting the carrier on the shaft has been adopted. Two shallow circumferential grooves are machined close together on the shaft, the carrier being a sliding fit on the intervening land, which is relatively narrow to permit the carrier to align itself within the pump chamber. Relative rotation between the carrier and the shaft is prevented by a cylindrical key that registers in grooves of semicircular section in the two components. Of these two grooves, that in the shaft locates the key axially.

The hollow rollers have a nominal outside diameter of [illegible] in and a bore of $\frac{21}{64}$ in. They are of an ordinary case-hardening steel, and their peripheral surfaces are given a fine ground finish. The three standard lengths of roller are 0·5, 0·7 and 0·9 in. For pumps embodying either of the two shorter rollers, a common body casting is employed, differing in respect of the depth of the counterbore for the cam and rotor, but a longer body casting is necessary to accommodate the 0·9 in rollers.

A high-grade nickel or nickel-chromium cast iron, heat treated, is the material of the ring cam. Tests revealed that this type of material has good wearing properties and is highly resistant to the combined rolling and sliding action of the rollers under the pressures involved. Since the cam has an axial thickness slightly greater than the depth of the counterbore in the body, it is clamped in position by the tightening of the screws that secure the end cover. Location of the cam, to prevent its rotating, is effected by means of a small peg, which is pressed into an axial hole in the body, near the periphery of the counterbore, and registers in a groove in the cam. An O-ring seals the joint between the body and the cover: it is installed in a groove formed between the end of the cam ring and the counterbore in the body, by shouldering the periphery of the ring.

For reasons that will be explained later, the cam has a complex form, which is produced automatically on a profile grinder. Starting from the point of minimum volume, between the discharge and inlet ports, the first 35 deg of the cam profile consists of an arc of constant radius, struck from the centre of the shaft. The next portion, covering 100 deg, represents the intake period, during which the cam radius is progressively increased. For the remaining 45 deg of the first half-cycle, the radius is reduced again, though by a substantially smaller amount. Between the 180 deg and 240 deg positions, there is a second arc of constant radius, and then follows the discharge period of 85 deg, during which the radius is reduced to its original value. The final 35 deg of the cam profile constitutes an arc of constant radius identical with the first one. Over the 70 deg of the arc of the minimum volume portion of the cycle, there is only a running clearance between the cam and the carrier.

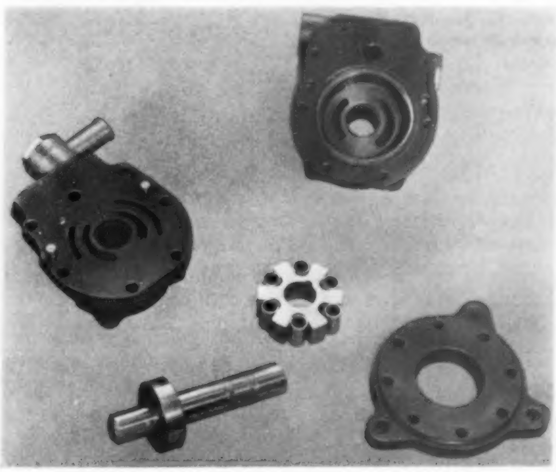
A Purolator 7-micron filter, having a paper element, is housed in the reservoir, which is of pressed steel construction and has a detachable top cover for access to the element.

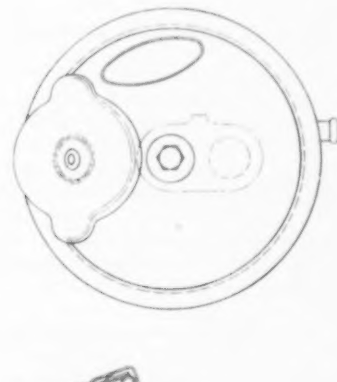
On the top cover is a filler neck surmounted by a bayonet type cap. The nominal capacity of the reservoir is about 1½ pints, so the total quantity of fluid in a typical power-assisted steering installation would be about 3 pints.

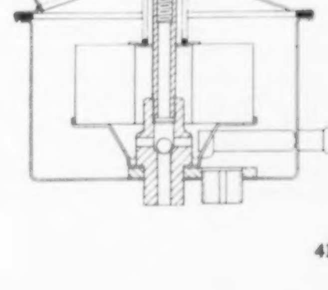
In the base of the reservoir are two unions and, in the standard layout, there is a third connection on the side, near the bottom. One of the unions in the base is connected to the intake side of the pump, and the other serves as a return for part of the fluid by-passed when the relief valve is blowing off; this provision has been adopted to minimize any tendency to overheating of the recirculating oil. The side connection on the reservoir is the inlet for the fluid returning from the external circuit.

This arrangement applies in all cases where the reservoir is mounted on the pump, since the two unions in the base support the reservoir. Where the reservoir is remotely mounted, the layout can be the same, the two unions being connected to the pump by flexible tubing. A different arrangement applies, however, for those steering installations embodying safety stops, within the box or for the drop arm, to prevent the wheels reaching the swivel pin stops. If the latter stops come into action, of course, the resistance of the wheels to the steering effort becomes virtually infinite, and the pressure build-up in the ram—which normally is proportional to this effort—must be limited by the relief valve, to avoid damage.

It follows that the use of safety stops obviates the possibility of the relief valve blowing off for lengthy periods, its action being restricted to those occasions when abnormal obstructions are encountered by the road wheels. For installations incorporating these stops, a remote reservoir layout is available in which the return from the relief valve to the reservoir is deleted. The central union in the base then takes the return from the system, and there is no connection to the side of the reservoir; a sealing plug is fitted to the relief valve orifice on the pump body.







Left: Components of a typical pump. The six hollow rollers and the arcuate ports, which are situated in the body and cover, can be clearly seen. Right: Sectional view of the reservoir, which has a capacity of 1½ pints

Porting layout

It is clear from the accompanying operational diagrams that the fluid space in each slot of the rotor is virtually divided into two by the roller. To provide the most efficient flow, therefore, there are two intake and two discharge ports, at different radii from the shaft axis. All the ports are of approximately arcuate shape. The inner ports register with the spaces between the rollers and the bottoms of their slots, whereas the outer ones are in communication with those between the cam and the lobes of the carrier. On the intake side, the outer port subtends a greater angle than does the inner port, but the converse applies in the case of the discharge ports.

As was mentioned earlier, the intake to the pump is in the end cover, and the outlet from it is in the body casting. The main intake ports are, therefore, also in the cover, but there is a second, similar set in the body. Part of the fluid by-passed by the flow-control valve is directed by an internal passage to the second set of ports, the object being to ensure complete filling of the pump in the limited time available at high rotational speeds. It will be appreciated that, if the working chambers of the pump are not completely filled when the discharge port is uncovered, back-filling occurs and causes noisy operation.

In the intake passage is a venturi tube, through which passes the flow from the reservoir. The remainder of the by-passed fluid is ducted to the annular space surrounding this tube, the outside of which is fluted to direct the fluid into the main stream with the minimum of turbulence. Although the main discharge ports are in the body, there are secondary, blind ports in the cover, the function of which is to give a more uniform pressure distribution than would otherwise occur.

Projecting, in the direction of rotation, from the trailing end of the main inner intake port is a short groove, known as the timing groove, that tapers in width and depth; there is a similar groove at the leading end of the inner discharge port. In addition, a groove of constant section, called the transition groove, extends circumferentially from the leading end of each intake port, and subtends an angle of about 20 deg at the axis of the unit, from which it is struck.

Operational cycle

As soon as the pump shaft begins to revolve, centrifugal force causes the rollers to move outward into contact with the cam. The circumferential position of each roller in its slot depends on the distribution of fluid pressure ahead of and behind it. During the filling portion of the cycle, the increasing volume between adjacent rollers causes oil

to be drawn into the pump. The position of maximum volume occurs when the leading roller of the pair is part way along the reducing arc between the 135 deg and 180 deg stations. This is known as the over-filling position and is shown in diagram A.

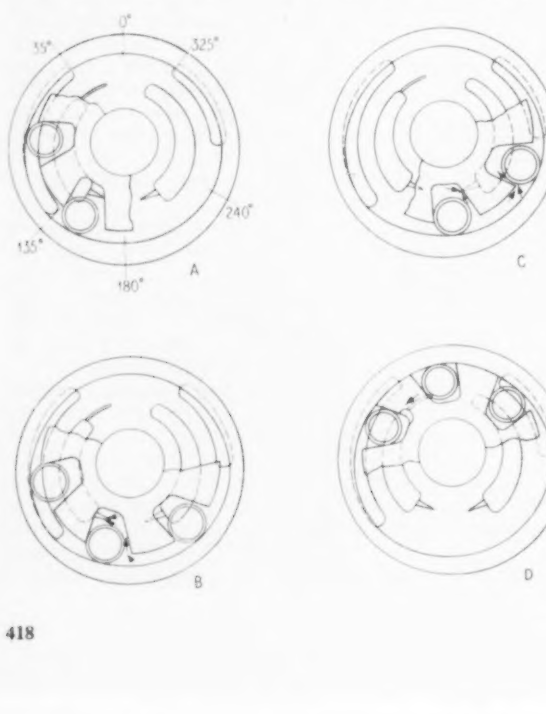
Further rotation results in a small reduction in the volume occupied by the fluid. The consequent pressurization, by the collapsing of any entrapped bubbles of air, ensures that the clearance space is completely full. If it were not, back-filling, with its attendant shock and noise, would tend to occur when discharge began.

This pressurizing stage of the cycle is shown in diagram B. The leading roller of the pair under consideration is still held against the trailing face of its slot, because the pressure ahead of it—the delivery pressure in the preceding space—is slightly higher than that behind it. Thus the inner of the two discharge ports is not yet effective. A similar pressure differential also holds the trailing roller on the trailing face of its slot. Over-pressurization is avoided by the timing groove at the trailing apex of the inner intake port: some of the oil bleeds back along this groove, thereby also assisting the filling of the succeeding space.

The timing groove just mentioned is cut off by the carrier lobe immediately before the trailing roller reaches the 180 deg station, at which stage the leading roller is coming on to the discharge portion of the cam. It follows that any additional rotation causes a further reduction in the volume between the rollers, and hence an increase in the fluid pressure. This situation is shown in diagram C, which illustrates the consequent check-valve action of the leading roller: as soon as the pressure exceeds the delivery pressure in the preceding space, this roller moves forward off the trailing face of its slot, and thus uncovers the inner discharge port. Since over-sudden opening of the port would give rise to noisy operation, the timing groove on the leading end of this port begins to become effective just before the roller moves forward.

To ensure that the leading roller does not move back again on to the trailing face of the slot, more of the discharge is taken through the inner port than the outer, which opens later on this account. When the roller passes beyond the ends of the discharge ports, a quantity of stagnant oil is trapped in front of it. Just past the 0 deg station, the carrier uncovers the transition groove, through which this stagnant oil escapes to the inner intake port. The roller then moves forward on to the leading face of its slot—the correct position for the start of the next intake stage. This final stage of the cycle is illustrated in diagram D.

Diagrams showing the operational sequence of the roller type pump



Flow-control and relief valves

Limitation of the flow rate is necessary in a power-assisted steering system because of the nature of the valves employed in the steering unit. By inserting a flow-control valve in the hydraulic circuit, the build-up of pressure with pump speed is limited, so excessive loading of the valves and generation of heat are avoided. In the roller type pump, the flow-control valve is ingeniously combined with the normal pressure relief valve.

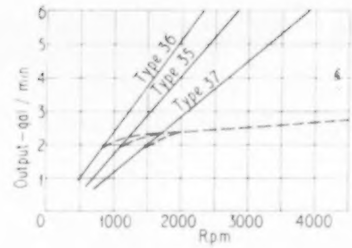
The valve is shown in section in the accompanying reproduction of the general arrangement drawing. Since its flow-control portion is operated by the pressure differential across an orifice, it is independent of line pressure. A series of circumferential grooves is machined round the bearing portion of the valve plunger, to minimize any tendency to sticking. The open end of the chamber that houses the plunger is closed by a screw-in plug and sealed by an O-ring.

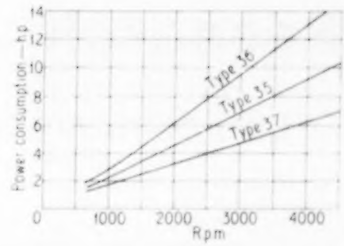
This view illustrates the form of the slots in the roller carrier. On the periphery of the ring type cam is a shoulder forming a groove for an O-ring

At its lower end, as illustrated, the plunger is reduced in diameter, and surrounding this smaller-diameter portion is an annular space communicating with the output side of the pump. From this space, a curved passage in the wall of the valve chamber leads to the orifice and thence to the discharge connection. One of the advantages of the shell moulding process is that it has enabled this passage to be cored, thereby saving drilling and plugging operations. The orifice is formed in the upstream end of an axially drilled plug pressed into the passage; the downstream end of the plug has a conical shape to mate with the flared end of the discharge connection. Forcing the plunger towards the lower end of the chamber is a helical compression spring. A cross-passage connects the upper portion of the chamber to the orifice tube, downstream of the actual restriction in this tube.

When the pump is running slowly, the pressure drop across the orifice is insufficient to move the valve plunger. As the velocity of the oil flow increases, however, the differential becomes sufficient to overcome the resistance of the spring, and the plunger moves off its seat on the plug mentioned earlier. When it has lifted a certain amount, the valve uncovers the by-pass port communicating with the intake side of the pump, and so limits the rate of oil flow through the orifice. The maximum output of the pump

Graphs of output and power consumption of the three sizes of pump. It is noteworthy that the type 36 pump, the largest in the range, consumes about 6 h.p. for an output of 5 gal/min, at just under 2,000 r.p.m. In the left-hand graph, the dotted lines show the effect of a flow-control valve





is, of course, determined by the characteristics of the spring and the size of the metering orifice.

Within the plunger of the flow-control valve is the pilot pressure relief valve, which is of the conventional spring-loaded ball type. The ball seat is near the upper end of the plunger, and an axial hole is drilled through the wall above it. It follows that the ball is subjected to the actual delivery pressure of the pump—downstream of the flow-control orifice. Should the ball be caused to lift, oil escapes past it to reduce the pressure in the spring chamber of the flow-control valve, thereby causing this valve to move against its spring, irrespective of the prevailing flow-control conditions. In this way, the flow-control valve also performs the function of the main relief valve. As soon as the pilot valve closes, the pressure difference across the orifice is restored, and consequently the flow-control valve resumes its normal function.

It will be noted from the sectional view of the pump that the static end of the pilot relief valve spring abuts against a fixed ball, the position of which clearly governs the load exerted by the spring. On assembly, the ball is pressed into the valve by a predetermined amount, and this simple arrangement has been found to give very consistent results. Manufacturing costs are reduced by having no adjustment for the spring, and a secondary advantage is that, in service, the pump cannot be damaged by unqualified persons tampering with the valve setting.

Speeds and outputs

Assuming normal conditions of operation, such as in a power-assisted steering system, the 0·5 in roller model—the type 37—can be run at any speed up to 9,000 r.p.m. when directly driven, and 7,000 r.p.m. when belt driven. The lower maximum in the second instance is dictated by the need to keep the PV value of the overhung bearing to a level consistent with long life. The types 35 and 36, which have roller lengths of 0·7 in and 0·9 in respectively, are limited to 7,000 r.p.m. even with direct drive, to ensure that the noise in running is kept to a satisfactorily low level. Graphs of outputs and power requirements against speed, at a delivery pressure of 1,000 lb/in², are reproduced. The effect of the flow-control valve is indicated on the output graph; the valve can be pre-set to give any output between 1·5 and 5 gal/min at a rotational speed of 3,000 r.p.m.

Monomer Casting

FINISHED nylon parts of considerable mass can now be produced. They are made from monomer instead of powders of nylon polymer. This news has been announced by the U.K. associated company of The Polymer Corporation, U.S.A, Polypenco Ltd, of 68-70 Tewin Road, Welwyn Garden City, Herts. The new process, performed at atmospheric pressure and described as monomer casting, is done by techniques similar to the conventional casting of metals, and is expected to open new markets for nylon.

The material, designated MC nylon, is a type 6 nylon formulation. However, it exhibits physical properties which span the range of properties obtainable in nearly all nylons in industrial use today. Until now, it has not been possible to realize in large components the inherent advantages of nylon because of the high tooling costs and the processing limitations of conventional moulding methods. In the casting of MC nylon, the direct production of the finished parts from monomer eliminates five steps in the processing cycle and thereby enables large parts to be made at lower costs than hitherto. Unlike other nylon conversion methods, monomer casting is performed at atmospheric pressure, and the need for expensive moulds, required in conventional injection or extrusion moulding of nylon polymers, is eliminated. The new process will not, however, compete with injection moulding now widely used for mass production of small parts.

Although the production methods employed are similar to those used in casting metals, chemical controls are required to govern the purity and temperatures of materials and moulds. Monomer casting also requires many entirely new handling techniques. The basic chemistry involved was discovered by the Monsanto Chemical Co. Numerous patent applications broadly covering the process have been filed by Monsanto and a number have been issued or allowed in the United Kingdom or abroad. Polypenco Ltd, through its parent company, The Polymer Corporation, Reading, Pennsylvania, U.S.A, has acquired the exclusive rights to use the process in the field of casting nylon shapes in the United Kingdom and many other countries, and has now developed the technology from laboratory scale to commercial production.

Castings made from MC nylon are said to be substantially lower in cost than comparable stainless steel or brass castings and to compete favourably in this respect with alloy steels. In the next few years it is expected that increasing volume and production economies will reduce the costs to about 50 per cent of the present level, making MC nylon competitive with carbon steel and aluminium castings.

The largest monomer cast MC nylon parts produced to date have been semi-finished symmetrical shapes in the 500 lb to 700 lb range. A steel casting of the same size would weigh over 2 tons. It is expected that a progressive increase in the size range capabilities will be achieved in the months ahead. Theoretically there is no technical limitation to the size of parts that can be made by the process.

Gear Type Pumps

A WELL-PRODUCED 34-page brochure entitled *Gear Pumps* has recently been issued by Brooke Tool Manufacturing Co. Ltd, Warwick Road, Greet, Birmingham, 11. It contains useful data on the standard and special pumps produced by this company; the information includes dimensions and output graphs for all the standard range, as well as a number of conversion and other tables. Copies of the brochure can be obtained on application, without charge.

Research on Non-Ferrous Metals

Some Aspects of the Work of the British Non-Ferrous Metals Research Association

The Association's laboratories are in an area where the atmosphere is extremely corrosive. On the flat roof are rows of these racks, for the outdoor exposure of a range of test samples for lengthy periods of time

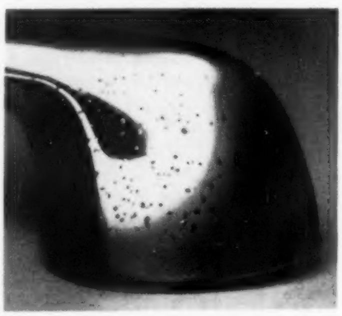
SINCE 1920, the British Non-Ferrous Metals Research Association has been not only carrying out its research work, but also providing technical advice and assistance to users and manufacturers of non-ferrous metals both in this country and in the Commonwealth. As a result of the increasing demand for the services of the Association, there has been a progressive build-up of scope and diversity of its activities and a gradual development of facilities, culminating, in 1959, with an expansion of the laboratory space and an increase in the size of the staff. At present, the Association's laboratories in Euston Street, London N.W.1 cover a floor area of 53,000 square feet, and expenditure on its services amounts to a quarter of a million pounds per year.

During the past year, more than sixty major researches have been undertaken or continued, all of them aimed at improving the quality, durability and reliability of non-ferrous metals and their alloys. There are 632 member firms, and they include the producers of the metals, and the manufacturers of sheet, strip, rod and tube. Besides these, there are die casters, galvanizers, electroplaters, founders, and many firms that are engaged in the manufacture of components incorporating non-ferrous metals. In addition to the work done for such of these firms as require it, there is that done under research contracts placed by Government Departments, the U.K. Atomic Energy Authority, and metal development associations in U.S.A. and Belgium.

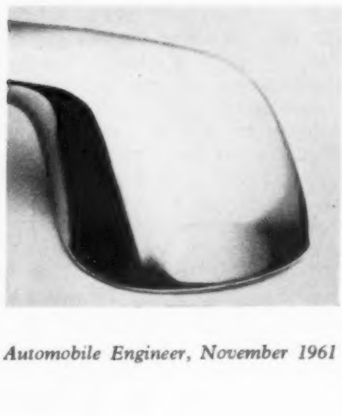
Although in various countries there are groups for organizing research, which have been established by the producers of zinc, lead, cobalt and copper, the Association is in full contact with these bodies and undertakes research projects for them on the understanding that the ultimate benefits are freely available to British member firms. In general, the results of all research work are available to member firms. However, there is an exception to this rule, and that is where the work is in the nature of a short-term trouble-shooting operation, in which case the firm requesting the work can ask for a confidential report.

The initial request for technical assistance, if it cannot be satisfied by recourse to the extensive sources of information at the disposal of the laboratory staff, is reviewed by the Association's Liaison Department. Generally, a short laboratory investigation is sufficient to overcome the problems being encountered by the member. Alternatively, a visit is made to the member's works, to arrange a programme of practical development work. However, there are occasions when it is clear that the background information needed for the solution of a problem does not exist, and long-term research effort is therefore required. Then, if the member agrees, the problem is passed on to the committee that deals with that branch of the work, for them to decide whether the investigation should be undertaken as part of the normal research programme. In this case, of course, the results would be available to all members.

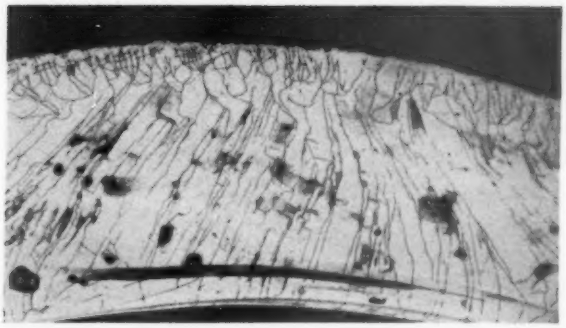
It is not a policy of the Association to charge for short-term investigations undertaken for members in confidence, as this would, in effect, tend to deprive smaller firms of very valuable technical assistance: obviously, though, the scope of such investigations is limited. This policy ensures that



Part of a conventionally chromium plated car door handle after six months out of doors in an industrial atmosphere



Component identical to that above, but plated by the improved process, after a similar period of outdoor exposure



Part of a diecast headlamp bezel, shown here full size, after exposure to industrial atmosphere. The chromium had been deposited thickly under conventional plating conditions, and has developed these stress cracks, through which the underlying layer of nickel has been exposed to attack

small firms in particular are, without delay, able to make good use of technical advances. However, a reasonable proportion of long-term programmes, which can be expected to continue over a number of years, is maintained.

Among the activities of the Association that are of interest to the automobile industry are the efforts to improve the durability of chromium plating, improvement of techniques for testing electro-plated coatings, development of the automatic analysis of alloys, and the study of aluminium alloys with a high silicon content, for application to cylinder block die castings. Other activities have been the commercial introduction of instruments for measuring the thickness of plated coatings, and the development of a device for correcting certain faults in rolled strip prior to slitting.

Electro-Plating

In the electro-plating laboratory, a major part of the research programme has been devoted to improving the durability of chromium plating, particularly that used on motor vehicle trim and hardware. Part of the work is specifically concerned with the plating of die-cast zinc-base alloy. Since the Association's headquarters are quite close to three large railway termini in the centre of a city, the atmosphere on its roof is one of the most corrosive in the country.

This is, if anything, a great asset in plating research, since any component that will stand up to the conditions on the roof is almost bound to do well in service. However, these exposure tests take a very long time, so a great deal of the laboratory's work has been aimed at obtaining accelerated corrosion techniques which can be correlated with normal service conditions, and can therefore be of value in acceptance tests and plating specifications, for both non-ferrous and ferrous basis metals.

In the study of accelerated corrosion testing, five corroding agents have been examined. The first is common domestic salt, which in the standard test is sprayed on the specimen at room temperature for 96 hours. Secondly, there is salt plus acetic acid, which is sprayed at 95 deg F for 72 hours. A third mixture is named C.A.S.S.—copper acetic acid salt spray. It is made up of salt, acetic acid and copper chloride, and is sprayed at 120 deg F for 18 hours.

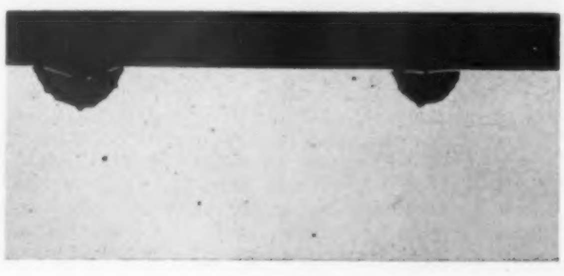
Sulphur dioxide is the fourth corroding agent. Specimens are exposed in an atmosphere of 1 per cent sulphur dioxide in air for 24 hours at a relative humidity of 95 per cent. The fifth agent is Corrodkote paste, which is a mixture of china clay, ammonium chloride, ferric chloride and cupric nitrate. After application, it is allowed to dry for one hour, and then the specimen is placed in air at 100 deg F and 100 per cent relative humidity for 20 hours. All but the first of these tests have been found to give useful results, but the salt test has been dropped because salt, used alone, was found to be insufficiently corrosive.

In addition to the exposure site on the roof of the laboratories, two others are also regularly used. One of these is at Banbury, Oxfordshire, and the other is at Hayling Island, on the south coast. Any test exposures made on the roof of

Photomicrograph of a section through nickel-chromium plating on steel, showing pitting corrosion of the plating. Magnification ×250

Nickel-chromium plating on a brass component. Magnification ×400

Early stage of nickel corrosion. Partial penetration of this layer shows that pitting attack arises from external sources. Magnification ×400



Right: The nickel layer, all of which is shown in this illustration, has been attacked through cracks in the chromium. Magnification ×500

the laboratories are simultaneously duplicated at the other sites, so that urban, rural and coastal conditions are studied at the same time. Although these are not the only sites used, it is considered that they are reliably representative of the overall conditions likely to be endured by chromium plated articles in service.

One of the results of investigations into plating processes is that it can now be demonstrated that by slightly altering the chromium plating procedure and increasing the thickness of chromium applied, the resistance to corrosion is considerably enhanced. This, incidentally, was mentioned in the leader in the August 1960 issue of *Automobile Engineer*. Samples of work plated by the modified process have been exposed to the atmosphere on the roof for over a year, and have shown a considerable improvement in performance relative to that of components plated according to the top grade of the current British Standard specification. Tests are now under way at the plating plant of a large manufacturer to examine the practicability and economics of the process under normal production conditions.

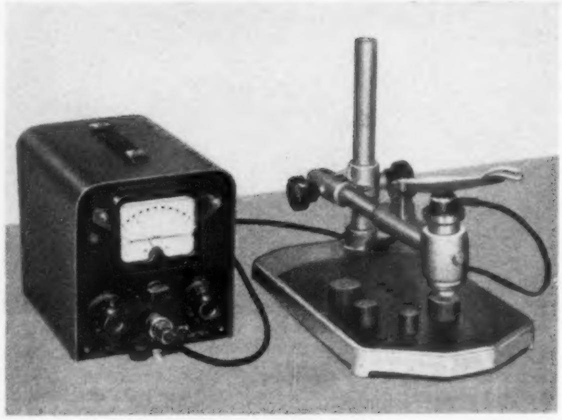
In conventional plating, the layer of chromium is deposited at a minimum thickness of approximately 0·00001 in, but it has been found that layers of this order of thickness tend to be porous. In thicker layers porosity does not appear, but the metal becomes prone to severe cracking, since it is deposited in a highly stressed condition. Difficulties arise in the plating of components of complex shape, in that chromium is unavoidably deposited thickly on some parts of the component in order that areas in which the current density is lower are adequately covered. It has been the task of the laboratories to work towards a process that will afford thicker coatings of crack-free chromium.

The British Standard Specification B.S.1224 lays down a minimum thickness of 0·00001 in of chromium. With the modified process, coatings of three or four times this figure can be applied without cracking occurring, either in the accelerated corrosion tests or during normal exposure on the roof. In this process, the concentration of chromic acid in the plating bath is 250 gm/litre, the current density is 300 A/ft^2, and the temperature of the bath is maintained at 130 deg F. The figures for conventional plating processes are respectively 450 gm/litre, 100 A/ft^2 and 100 deg F.

The ratio of chromic acid to sulphuric acid in this process is 150 : 1, whereas a ratio of 100 : 1 has hitherto been normal. Investigations into the effects of other concentrations or of different catalysts in the chromium baths have shown that there is little to be gained in respect of the corrosion resistance of thick, crack-free chromium if any departure from straightforward chromic-sulphuric acid solutions is made.

The laboratory has also been investigating the effects of variations in underlays and basis metals. This has, of course, involved a good deal of research on the electro-plating of zinc alloy castings by the duplex nickel process. In this, two coatings of nickel underlie the chromium, the first layer having a dull finish, and the second a bright one.

At one time it was thought that the nickel coating provided the real protection against corrosion, and served as a bright carrier for the chromium decorative layer. Now, however, it is realized that the nickel itself eventually corrodes and although an adequate thickness of nickel is essential, the thickness and quality of the chromium coating is of great importance. In the duplex nickel process, the bright nickel layer contains a small amount of sulphur, and is more affected by corrosive conditions than the dull nickel layer. Any porosity in the chromium leads to corrosion of the top layer of nickel, and this corrosion tends to spread laterally instead of deeply into the basis metal. To what extent this lateral spread is important, in delaying attack on the basis metal, is not yet clear, since in most of the practical tests carried out so far by the Association, the duplex nickel has



When the heated probe of this B.N.F. Plating Gauge is placed against the plated surface of the specimen, an e.m.f. which varies with coating thickness, is generated at the junction of the coating and the basis metal. This is amplified and registered on the dial and the reading compared with that of a standard specimen, to give coating thickness

not entirely prevented pitting corrosion extending through to the basis metal. However, this process, which has advantages in production as well, is being used a great deal in industry.

The laboratory, in common with other research organizations, is making use of radioactive tracer techniques. Many electro-deposited coatings are produced from solutions containing organic substances to improve the smoothness or the appearance of the coating, but sometimes these have less desirable effects. The reasons for the effects so produced have not been entirely clear, but with the utilization of radioactive-labelled compounds has come some understanding of variations in plating behaviour, of the problems connected with formation of adsorbed films on metallic surfaces, and of the decomposition of organic additives which leads to the build-up of harmful products in the bath. For example, some organic additives containing radioactive carbon or sulphur are being used, and their presence in the deposit and the solution is being investigated.

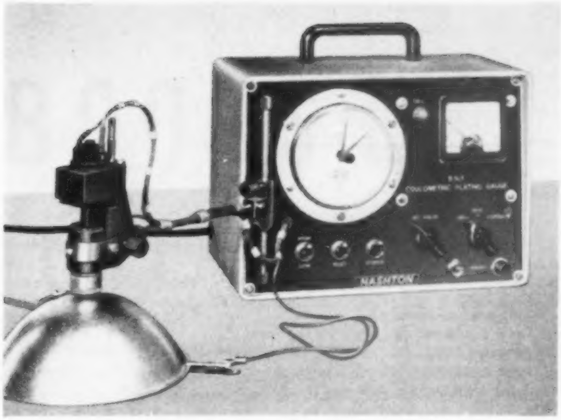
Plating Gauges

Two gauges for measuring the thickness of plating have recently been announced by the Association, and are now in commercial production. One of these, the B.N.F. Plating Gauge, is an improved version of an earlier development. It is a non-destructive method of measuring, quickly and accurately, the thickness of a plated deposit. The other, designated the B.N.F. Coulometric Meter, is a very accurate instrument which is destructive of the plating, and although it was developed primarily for calibrating the plating gauge and for routine determination of chromium thickness, it has very wide uses for measuring plated coatings.

In the first of these two instruments, a thermo-electric principle is applied. A probe, heated to a standard temperature, is placed on the plated surface, thereby creating a temperature gradient across the coating. The thermo-electric e.m.f. generated at the junction of the coating and the cooler, basis metal, is amplified and recorded on a meter.

Since this e.m.f. falls as the thickness of the coating increases, the thickness of that on the specimen can be determined by comparing its e.m.f. with that obtained from a standard specimen of similar metals. The thickness range of the instrument is 0·0002 in to 0·002 in, with an accuracy of $\pm$0·0001 in.

In the Coulometric instrument, the plating is stripped electrolytically from a small part, of known area, of the plated



The cell of this B.N.F. Coulometric Gauge has been placed against the top of the domed component, from which an area of approximately $\frac{1}{32}$ in diameter will be stripped electrolytically. Time taken and current required to complete the process are fed to an integrator, so that the volume, and hence the thickness, of plating can be deduced

surface, and the quantity of electricity required for the operation is recorded. From this, the weight of coating can be deduced, and hence its thickness.

The instrument consists of a small cell which has walls of stainless steel and a base of flexible plastics material, in the centre of which is a circular hole of standard diameter. When, therefore, the base is pressed against the plated surface, this hole encloses a known area of plating. The cell is filled with a special solution, and a current is passed between the testpiece, which acts as an anode, and the interior wall of the cell, which is the cathode.

A current integrator incorporated in the instrument gives a reading based on the current required to strip the coating, and the time taken to complete the operation. From this reading the thickness of chromium deposit can be deduced. The characteristics of the solution chosen for this electrolytic action are such that there is a sharp change in voltage when the last of the plated layer is removed; this change operates a relay, to stop the integrator.

Automatic Analysis of Alloys

In manufacturers' laboratories, optical spectrographic analysis equipment has, for many years, been used for the determination of trace impurities and minor alloying additions. The reliable and rapidly obtained results have been of great value to those responsible for quality control and the maintenance of material standards. However, the growing demand for more accuracy than has hitherto been asked of the equipment has led to the need for stricter control of the process.

In this spectrographic technique, a spark is passed between the specimen to be analysed and a graphite electrode, and then the intensities of the spectrum lines produced by the elements of interest are measured. This spectrum is then compared with other spectra produced by accurately analysed standard specimens of composition similar to the test metal. For accurate results to be obtained, the spark discharge must be carefully controlled, as also must the preparation and analysis of the standard specimen. These matters have been the subjects of much attention by the laboratories.

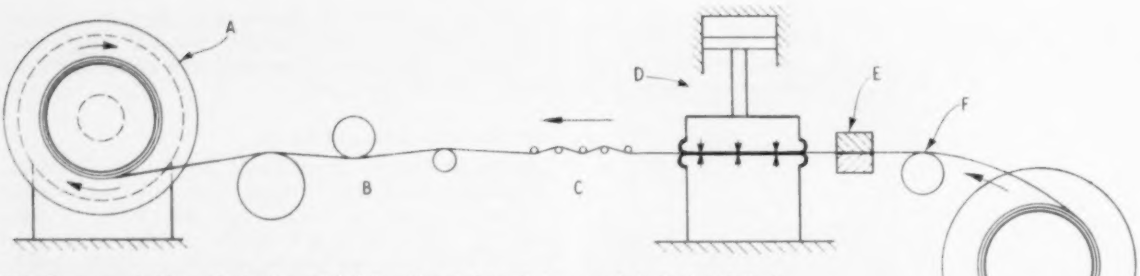
A more recent method of rapid metallurgical analysis is the X-ray fluorescence technique, which in its present stage of development is being used for the determination of major constituents of metals, and is thus complementary to the optical spectrograph. The principle on which the X-ray fluorescence method is based is as follows: the sample is irradiated in an intense beam of X-rays, which causes the emission of fluorescent X-rays having wavelength emissions characteristic of the elements present in the alloy.

An X-ray spectrometer is used to analyse the X-ray spectrum, and by comparing the spectra of the samples with those of standard alloys, an accurate analysis can be obtained rapidly. Instruments are now available commercially with which a number of elements can be determined

Automatic X-ray fluorescent spectrometer. An intense beam of X-rays is directed vertically upwards on to the test samples, which are held at an angle in the four inclined cylinders on the right. Fluorescent X-rays are emitted, and they travel horizontally through a collimator to a crystal analyser that is mounted on the goniometer, or graduated turntable, which is in the centre of the cabinet. A scintillation counter is mounted on the pivoted arm to the left of the turntable, and the speed of its sweep is twice that of the crystal. A preliminary sweep reveals the constitution of an alloy, and a count at the characteristic angle for each element determines the concentration. On the left is the control panel, which incorporates a pen recorder, and beside it is the printer that produces coded results

Right: Diagrammatic plan:

A Specimen; B Incident radiation; C X-ray tube; D Collimator, consisting of fine parallel tubes; E Crystal analyser; F Auxiliary collimater; G Counter; H Sweep of counter; J Centre of rotation of goniometer



This diagrammatic illustration is of a model of the roller stretcher that was made in the Association's laboratories. The sheet metal is taken up by the powered coiler A from the coil G, and is in a state of tension as a result of passing between the pressure pads D. These pressure pads are pneumatically loaded. Five small-diameter rollers at C are arranged in the same plane, and the sheet passes alternately under and over successive ones while subject to a tensile strain of between 1·5 and 2 per cent; during this stage the internal stresses in the sheet are neutralized. There are three further rollers B, of progressively larger diameter but not co-planar with one another; the sheet passes over and under these, so that any tendency to curling that it may have is thereby considerably reduced

within two minutes of the sample's being placed in the instrument. As with the optical spectrograph, the saving in time, as compared with that needed for conventional methods of analysis, is obvious, and melts are being analysed and adjusted to the correct composition before a casting operation is carried out.

Roller Stretcher

One of the requirements dictated by the in-line layout of many press tool machine lines is that the strip metal fed to the machines should be flat and straight. If these conditions are not observed, serious jamming and wastage can occur. Since most strip is manufactured from wide sheets, slit into appropriate widths, there is frequently some degree of distortion in the strips, owing to the release of complex locked-up stresses when the slitting operation is performed. This is particularly liable to occur in strips cut from the outer edges of the sheet.

Flatness is normally ensured by subsequently passing the strips through levelling rollers, and straightness is obtained by subjecting each to a small degree of strain before feeding it to the presses. In the B.N.F. roller stretcher, these two operations are performed simultaneously. The material leaves the rolling mills, but before being taken up by the strip coiler, it is passed, whilst in tension, through a series of small-diameter, offset rolls, so that the internal stresses are neutralized. There is usually sufficient power in the coiler to provide the tension that is required for this operation.

Multicolour paint

ALMOST invariably, a great deal of surface preparation necessarily precedes paint-spraying operations in which appearance is of primary importance. There are occasions, however, when a smooth, polished, final surface is not desired, or when a change from conventional finishes is welcome. Advances in the technology of paints, resins and lacquers have now made possible the spraying of deposits with a flecked appearance, and these are found to be both useful and decorative in many branches of industry.

Any number of unmixed colours, as particles, can be mixed in one container, and deposited with one pass of a spray gun. These particles are held in fluid sacs suspended in a nitrocellulose base, and can be in fine, medium or large sizes according to the appearance desired. A full range of fleck paints is being marketed by S. E. Porter and Sons Ltd, Argall Avenue, Lea Bridge Estate, London, E.10, under the name Porterfleck. They contain resins claimed to give characteristics of hard wear, elasticity and good adhesion.

A reproduction of a flecked coating that embodies three separate constituents, and was deposited with only one pass of a spray gun

Because the number of constituent colours, and their particle sizes, are variable over wide ranges, virtually a limitless selection of pattern variants can be obtained. Porterfleck is an air-drying paint which can be applied only by spray application, but it does not require special spraying equipment. For best results, it is advisable to make two passes, the direction of stroke of the second one to be at right angles to that of the first.

Porterfleck paints are particularly suitable for painting the rough and usually unsightly interior surfaces of car body components made from fibre-reinforced resin, and are already being used by some manufacturers to cover facia panels made of compressed fibre materials. The manufacturers claim that, by the selective mixing of large and small particles, multicolour paints can be made to simulate cloth fabrics, wood, leather, and various types of masonry.

Refinishing

THE Paints Division of I.C.I. has recently introduced a new publication entitled "Refinisher". It will be issued at least three times a year, and will be distributed to refinishers and users of transport paints. The aim is at offering advice on materials available and ways of improving techniques.

BOOKS

Brief Comments on Recent Publications Pertinent to Automobile Engineering

Principles of Manufacturing Materials and Processes
By J. S. Campbell Jr.
London: McGRAW-HILL PUBLISHING CO. LTD, McGraw-Hill House, 95 Farringdon Street, E.C.4. 1961. $9\frac{1}{4} \times 6$. 674 pp. Price 76s.

In this work the aim is at pointing out the basic principles involved. The presentation is suitable for students and is designed to fit in with other courses they will have studied previously, for example, chemistry and physics. The author has gone to some trouble to present the basic reasoning behind the development of each important manufacturing process.

Line diagrams, instead of half-tone illustrations, are used in many instances, since it has been felt that in this way the features considered to be important and pertinent could be most clearly presented. Although some portions are suitable mainly for junior or senior engineering undergraduates, most students should be able to understand the material.

The list of chapters is as follows: Introduction; Measuring and gauging; Metallurgy and metals; Heat treating of metals; Moulds and cores for sand castings: smaller-quantity production; Solidification, gating and risering; Sand moulding: large-quantity production; Melting; Cleaning and finishing; Sand-casting defects and inspection methods for defects; Product development and the design of sand castings; Other casting processes; Powder metallurgy; Plastic-flow and mechanical-working fundamentals; Rolling and forging; Other mechanical-working processes; Welding, brazing, and soldering processes; Plastics: their moulding and forming; Metal cutting in machining; Machining with the shaper and planer; Machining of cylindrical holes; The lathe family of machine tools; Milling and similar machining processes; Abrasive machining processes; Sawing, broaching, and gear cutting; Recent developments in the manufacturing processes; and Index.

Olyslager Motor Manuals
By Piet Olyslager, M.S.I.A, M.S.A.E.
London: THE SUNDAY TIMES, 200 Gray's Inn Road, W.C.1. 1961. $8\frac{1}{2} \times 5\frac{1}{4}$. Price 4s. 6d. each.

So far, we have received numbers 1 to 8 of these manuals for review. No. 1 is on the Renault Dauphine, including Dauphine-Gordini, Floride and Caravelle, and the Ferlec automatic clutch; No. 2 covers the Volkswagen cars from 1954, utility vehicles from 1955, and the Karmann-Ghia version from 1955; No. 3 manual is on the 1951 to 1956 Mark I Ford Consul, Zephyr Six and Zephyr Zodiac. In the fourth manual, the Hillman Minx Series I–IIIB from 1956 are dealt with, as well as the Husky Series I and II from 1958; it also covers the saloons, convertibles and estate cars. Manual No. 5 is on the Ford Consul, 1700 Mark II and the Zephyr Zodiac 2500 Mark II; and it covers the saloons, convertibles and estate cars from 1956. In the sixth manual are details of the Ford Anglia 105E and Prefect 107E saloons from 1959. The Olyslager Motor Manual No. 7 is devoted to the Peugeot 203, 1956 to 1960, and 403, 1959 to 1960; the saloons, convertibles, estate cars and vans are dealt with. No. 8 manual is on the Ford Anglia, Prefect, Popular, Escort, Squire and the 300E Thames vans; the car models are the 100E saloons and the estate cars from 1953.

The Piet Olyslager Motor Manuals have been known on the Continent for about ten years. They are compact and remarkably complete, containing the information needed for service, maintenance and repairs. In the English language they are presented in two forms: one is a small book covering individual models and the other is in a cumulative loose-leaf form, with which it is possible to keep abreast of alterations and developments.

In each, the contents are generally as follows. The book opens with an introductory section containing information such as the models available, colours and other variations, as well as chassis and engine numbers and the dates that they were produced. After this there are sections giving dimensions and technical specifications. Next come instructions for lubrication and maintenance, followed by repair data. It is intended that this series shall eventually cover all popular cars produced throughout the world.

Aids to Machine Shop Practice
By. C. T. Bower, A.M.I.Prod.E.
London: ODHAMS PRESS LTD, Long Acre, W.C.2. 1961. 8×5. 208 pp. Price 18s.

More than 200 hints and designs for new devices, improved production methods, time savers and suggestions for simplifying work and increasing output are described in this book. Line and half-tone illustrations are included to show the essential details, so that the reader can easily make up any of the devices described, or modify machines and tools as suggested. In general, the ideas put forward are both simple and inexpensive, and no attempt has been made to copy equipment that is already available commercially.

Originally, the ideas were published as a popular series in *Machine Shop Magazine*. The author, C. T. Bower, is a well-known writer in the field of production engineering and has had a wide industrial experience in both Great Britain and the United States. He has also written a companion volume, "Aids to Workshop Practice", which deals in a similar manner with hand and portable power tools. The list of contents is as follows: Assembly methods; Drawing office aids; Drilling and tapping; Gauging and testing; Grinding practice; Work handling; Jigs, fixtures and machine attachments; Lathe work; Machine-shop maintenance; Marking out; Milling work; Production methods; Welding practice; and Index.

Industry and Careers—A study of British industries and the opportunities they offer
Edited by D. E. Wheatley, M.A, B.Sc.
London: ILIFFE BOOKS LTD, Dorset House, Stamford Street, S.E.1. 1961. 10×6. 872 pp. Price 55s.

"Industry and Careers" provides an entirely new, thorough and analytical treatment of the problem of choosing a career. As its title suggests, it does not follow the conventional pattern of career guides, but gives first a full and detailed description of each industry and then—against this background, which is essential for a thorough understanding—it goes on to review the career prospects. All industries are covered except those in which opportunities are limited, and while the main emphasis is on careers leading to responsible positions, the book also covers trades and crafts.

The three opening sections deal with the philosophical

background of the approach to starting a career, and are written by authorities experienced in advising young people. They cover problems such as whether, by reason of talent, temperament and inclination, a prospective entrant is likely to be suited to a particular type of work, and deal with methods of selection and training for positions of higher responsibility. The last two sections in the book deal with advanced education and scholarships.

In the main body of the work each industry is thoroughly analysed on the following lines: its size, location, organization and managerial structure; the materials, techniques and plant it uses, and its attitude towards research; its personnel at every level, their work and their skills. These sections in fact constitute a unique textbook on the structure of British industries. After this detailed study of each industry is a review of its career prospects: how it may be entered; what educational and other qualifications are necessary for advancement, and how they can be obtained; what training schemes, if any, there are for technologists and management.

A noteworthy feature of "Industry and Careers" is the extensive use of coloured charts to show paths of promotion, systems of organization and the sequence of operations in industrial processes. In addition the book contains many half-tone illustrations which convey the atmosphere of the various industries. The work has been produced under the General Editorship of Mr. D. E. Wheatley, Deputy Director of the City and Guilds of London Institute, with the guidance of a distinguished Editorial Advisory Committee. It has received the full support of the Federation of British Industries and the City and Guilds of London Institute, and the collaboration of the professional institutions, manufacturing and trade associations, and leading companies in the various industries.

The Foreword has been written by H.R.H. The Duke of Edinburgh, and the contents are as follows. Part I: Foreword; Planning a career; The way in; and Opportunities for women. Part II: Agriculture, horticulture, forestry and related services; Mining and quarrying; Food, drink and tobacco; Chemicals, etc.; Metal manufacture; Engineering; Shipbuilding and ship repairing; Textiles; Leather industry; Clothing and footwear; Bricks, pottery, glass, cement, etc;. Furniture; Paper and printing; Other manufacturing industries; Construction; Gas and electricity (supply); Transport and communications; Specialist services; Further education; and How to find out.

F.I.S.I.T.A. 1960
Haarlem: H. D. TJEENK WILLINK AND ZOON N.V, Holland. 1960. $9\frac{1}{2}\times 6\frac{1}{2}$. 583 pp. Price 40 Fl.

This is the proceedings of the Eighth International Congress on Automobile Technology. The papers are in either German, French or English, and the discussions at the end of each are in the language of the paper, regardless of the nationality of the contributor. Each paper begins with a summary in all three languages. In this particular volume, eighteen papers are in the English language, six in German and five in French. All are by well-known engineers in the world's motor industry. Some come from as far away as Japan. Since the F.I.S.I.T.A. Congress is so well known for bringing to light papers of the highest technical order, there is no need to make further comment on the quality of the material in the book. It is, indeed, a work that every good technical library should contain and which most professional engineers will wish to have on their shelves.

The contents are as follows: The automobile of today; The automobile of the near future; The automobile of the distant future; Recent developments in automotive fuels and lubricants; Progress in motor fuels; Combustion problems in gasoline engines; Temperature rise of the mixture drawn into a petrol engine cylinder, due to heat from the hot surfaces of its passage; Development of automatic transmission fluids; Prevention of air pollution from vehicle exhausts; Belästigung durch Abgase, Gemischbildungsverfahren und Betriebsverhalten von Fahrzeugmotoren; Considérations sur la lubrification du générateur à pistons libres; Injection versus carburation, a comparison of fuel quality requirements; Konstruktionsund Prüfstandsergebnisse mit Kreiskolben-Verbrennungsmotoren; État actuel des problèmes de suspension, d'amortissement et de tenue de route; Le problème du freinage des véhicules routiers examiné du point de vue des prescriptions techniques; A European all-weather chassis dynamometer; L'amélioration de la suspension des véhicules dotés de suspension mécanique; Über die Möglichkeiten und Grenzen konstruktiver Sicherheit im Kraftfahrzeugbau; Erhöhte Bremssicherheit der Sattel- und Lastzüge, Experimental and theoretical research on mass-spring systems; The use of proving ground facilities in the development of commercial vehicles; A review of problems and developments in electric ignition equipment for piston engines; Die Bedeutung der Halbleiter für die elektrische Automobil-Ausrüstung; Aerodynamics and the modern car; Selbsttragende Autobuscarrosserie; Materials selection for automobiles in the U.S.A; How to select new materials for the automobile; Commentaires sur l'organisation d'un réseau d'après-vente a l'étranger; Why is the American car built as it is built? and Index.

Selected Papers on Stress Analysis
London: CHAPMAN AND HALL LTD, 37 Essex Street, W.C.2. 1961. $10\frac{3}{4}\times 8$. 114 pp. Price 50s.

In April 1959, the first conference of the Stress Analysis Group of The Institute of Physics took place in Delft. 51 papers, in English, French or German, were presented and discussed. The main topics were methods of stress analysis and their application. In some instances, these papers had already been published and, in others, their physical aspect was subsidiary to wider interests; those of both categories were unsuitable for reproduction in full in the volume under review, which contains eighteen of the papers.

All in the volume are printed in their original languages, together with summaries in the three languages of the conference, which were English, German and French. An English *résumé* has been prepared of the remaining thirty-three papers. Of the eighteen, there are ten in English, six in German, and two in French. The list of contents is as follows. Papers published in full, with abstracts in English, French and German: Die BAM-Setzdehnungsmesser-System von Pfender; New fields of application for the Moiré method; An automatic strain-measuring device; A survey of the possibilities of magnetic registration for measuring purposes; An example of stress analysis without strain measurements; Quantitative Ermittlung dynamischer Spannungszustände an quergestossenen Biegeträgern mit Hilfe von Funkenkinematographie und Spannungsoptik; Bending stresses in a shaft with a transverse hole; Bietrag zur spannungsoptischen Untersuchung von Schalen; Einige neue spannungsoptische Verfahren; Emploi de la méthode photoélastique pour l'étude des contraintes résiduelles; Method for the photoelastic measurement of stresses "in equilibrium in the thickness" of a plate; Stress analysis on three-dimensional models; The measurement of small displacements by electrical screening; Der Spannungszustand in gekerbten Stäben und sein Einfluss auf die Fliessgrenze und die Sprödbruchneigung von Stählen; La dynamométrie de precision; Mercury slip-rings; A strain gauge calibrator for temperatures up to 700 deg C; Messungen von mechanischen Spannungern an umlaufenden Teilen in Flüggeraten; Summary of the 33 papers not published in full; and Authors and titles of summarized papers.

Dynamics of Tracklayers

Results of Field Experiments and Their Correlation With a Theoretical Analysis

By L. F. LITTLE M.I.Mech.E.

NOMENCLATURE

- F Frictional resistance to motion, lb
- g Distance from rear roller axis to CG, in
- H Track pull, lb
- h Height of drawbar from ground, in
- l Length of track contact, in
- O Rear roller axis
- P Drawbar resistance, lb
- p_a Average track pressure, lb/in^2
- p_m Maximum track pressure, lb/in^2
- R Soil resistance to motion, lb
- r Height of rear roller axis from ground, in
- W Weight of tractor, lb
- x Distance from rear roller axis to centre of pressure, in

The holding recently of the First International Conference on the Mechanics of Soil-Vehicle Systems, in Turin, is indicative of a wide and growing interest in the problems of cross-country vehicles, and the papers presented show the considerable progress that has been made during the last few years in the testing and classification of soils and the evaluation of their properties in terms of vehicle mobility.

One aspect of the subject, however, which has received relatively little attention is that, in arriving at the loads imposed on the soil, not only vehicle geometry but also vehicle dynamics should be taken into consideration. A significant figure for the unit pressure under a tracklayer, for example, cannot be obtained by dividing the weight by the contact area of the track, since the forces resulting from drawbar reaction and soil resistance have a considerable effect on load distribution and consequently soil pressures. If, therefore, the designer is to take advantage of the new techniques in the prediction of performance he must have some means of calculating these forces.

The following article, based on the results of full-scale field experiments in which actual track pressures under varying load conditions were recorded, offers a method of analysing the forces involved and shows how this analysis can be applied for the determination of the effect of basic design proportions on the performance of a conventional crawler tractor.

IT is well known that the passage of a track over soft soil leaves a rut, the cross-sectional area of the rut is a measure of the power consumed, and the depth will be decided by the maximum pressure at any part of the contact between track and soil. The extent to which the soil is stressed in the horizontal plane will also decide the propulsive thrust that can be developed by the track. Therefore, the maximum pressure between the track and soil is the limiting factor as regards performance. It determines the maximum thrust that can be obtained from a soil of given shear strength and also how much of this will be lost in overcoming tractive resistance.

In this article, the intention is to examine the vehicle, rather than the soil aspect of the problem, but one soil characteristic perhaps requires emphasis: sinkage, in a large proportion of soils over which tracklayers are called upon to operate, increases faster than the load. Since the resistance to motion is proportional to the sinkage, it is obviously important for the designer to know what the track pressures really are under operating conditions—a relatively small change in loading may make a considerable difference in performance.

While it is generally accepted that track pressures under a vehicle in motion exceed the figure arrived at by simply dividing the weight by the track area, the extent of the increase due to the dynamic forces induced by soil resistance and drawbar pull is much less widely appreciated.

Experimental results

To obtain a clear picture of what really happens under the track of a crawler tractor, a reliable means of measurement is, of course, required. With this objective the device shown in Fig. 1 was developed.* It is a special track link incorporating strain gauge weighing elements which, when assembled into the track chain and connected by a roving cable to a dynamic strain recorder, Fig. 2, enables a continuous record of the load throughout the ground contact to be obtained. As can be seen from the illustration, the construction finally adopted for the weighing link is simple and robust. Instead of the link assembly being bolted in the normal way directly to the track plate, the load is transmitted through spring steel plates to which the strain gauges, patterned to cancel all but vertical load signals, are applied.

The method does, of course, have limitations: because of the need of avoiding major inertia effects it can be used only on a smooth surface and at low speeds. Under these conditions, however, it records pressures with reasonable accuracy and since, during its cycle of operation in contact with the

**Some Problems in the Design of Crawler Tractors. L. F. Little, Proceedings, of the Automobile Division of the Institution of Mechanical Engineers, 1959-60. p 193.*

ground, the weighing link remains constantly on one portion of soil, ensures that track plate pressures and not variations in soil strength are being measured.

Trace records, shown in Fig. 3, were obtained during tests of a 38,000 lb crawler tractor on a track of smoothed sand the physical properties of which were: cohesive stress 0·5 lb/in^2; angle of friction 35 deg. This proved to be a very stable soil medium and gave good repeatability of results.

To show clearly how the pressure distribution over the track is affected by load conditions, the trace records have been transferred to Fig. 4. From this illustration it can be seen that, when the tractor is moving slowly forward with no drawbar load, seven closely spaced rollers on the track frame ensure a substantially uniform pressure over the track, although there is a small transfer of load from front to rear owing to the resistance of the soil. With a drawbar load of 20,000 lb, however, the change in load distribution is considerable: the front of the track is carrying no load and the pressure on the soil at the rear has been doubled. It should be noted that this is not at maximum drawbar pull, but when the tractor is pulling only just over half its weight, approximating to an average operating condition.

Analysis of dynamic forces

From the quantitative result obtained experimentally, it is possible to propose an analysis of the forces responsible for the change in load distribution and to use the experimental data to check the validity of the method. The forces acting on a crawler tractor in operation are shown diagrammatically in Fig. 5. Take moments about the rear roller axis O: track pull H is equal to the total resistance to motion, that is, the sum of the drawbar resistance, soil resistance and track and roller friction, $P+R+F$; and it is also equal and opposite to the horizontal reaction of the soil. The corresponding reaction on the tractor, since its rotation about O will be resisted by track and roller friction, results in a moment $(H-F)r$ where r is the height of the roller axis from the ground.

Obviously, the drawbar resistance will be equal to the track pull less soil and frictional resistance:

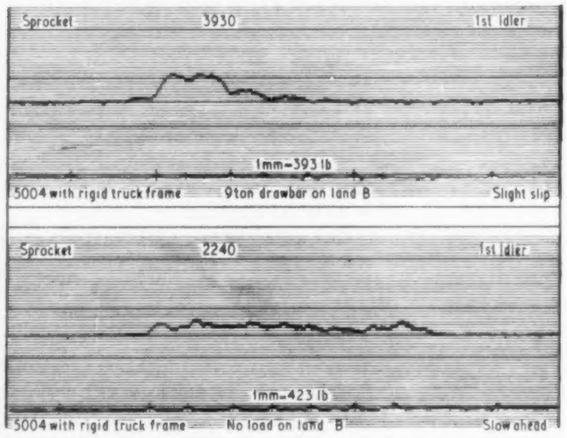
$$P=H-(R+F) \qquad \ldots\ldots 1$$

and the moment $P(h-r)$ will depend on the vertical dimension from the drawbar hitch to the roller axis.

The effect of these moments is to displace towards the rear the centre of pressure on the track, from its static location immediately under the centre of gravity; and the equation for equilibrium of the tractor when pulling a load on the level may be written:

$$Wg-(H-F)r-P(h-r)-Wx=0 \qquad \ldots\ldots 2$$

Fig. 3. Records of dynamic load distribution over a crawler track



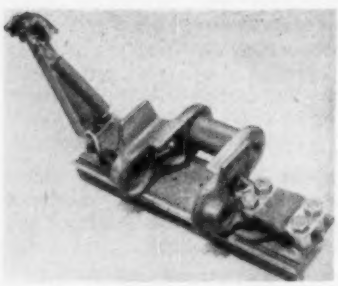
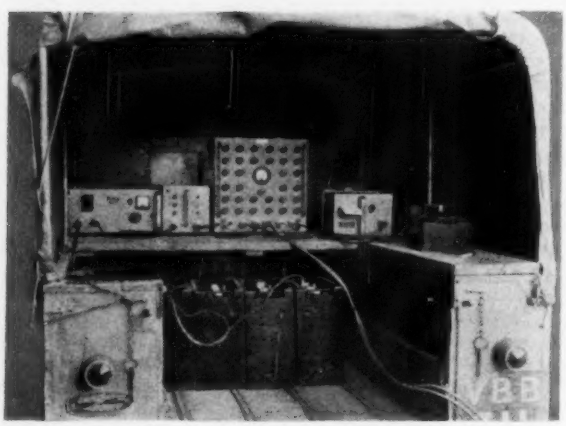


Fig. 1, left: Special track link incorporating strain gauge weighing elements, which are connected by a roving cable to the recorder

Fig. 2, below: The Kelvin and Hughes dynamic strain recording equipment used to make traces of the output of the strain gauges above



where W is the weight of the tractor and g the dimension from the CG to the rear roller axis. Dimension x from this axis to the dynamic centre of pressure will then be:

$$x=g-\frac{(H-F)r+P(h-r)}{W} \qquad \ldots\ldots 3$$

Assuming that the track presents a rigid surface to the soil, and the sinkage is relatively small, this will result in an increase in pressure to p_m under the rear roller, where

$$p_m=2p_a\left(2-\frac{3x}{l}\right) \qquad \ldots\ldots 4$$

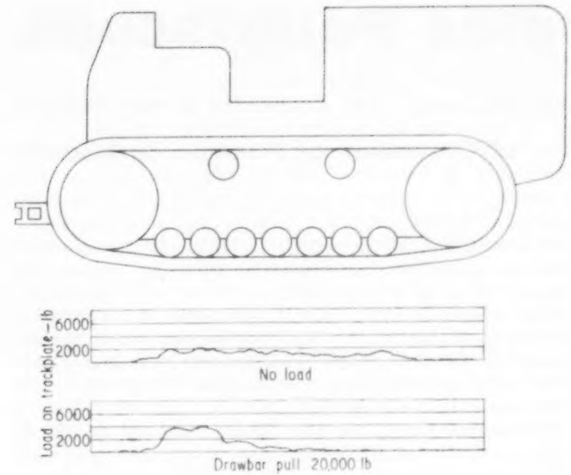
p_a being the average pressure on the track surface and l the length of ground contact.

To demonstrate the application, these equations will be used to determine the effect on tractive resistance of the increase in soil pressure shown in Fig. 4. The relevant particulars of the test tractor are: weight W, 38,000 lb; length of ground contact l, 60 in; height of drawbar h, 18·5 in; distance r, between axis of rear roller and ground 9 in; axis of rear roller to centre of gravity g, 30 in; number of track plates in contact with the ground, 10.

In the static condition, since $g=l/2$, the weight will be equally distributed over the 10 track plates on each side, and each plate supports a load of 38,000/20 = 1,900 lb. From the record taken when the tractor was pulling a load of 20,000 lb, it can be seen that the load p_m on the track plates under the rear rollers was 3,900 lb, and 3,900/1,900 = 2·05 times the average, p_a.

From equation 4, the location of the centre of pressure under these conditions is found to be:

$$x=\frac{l}{3}\left(2-\frac{p_m}{2p_a}\right)=\frac{60}{3}\left(2-\frac{2{\cdot}05}{2}\right)=19{\cdot}5 \text{ in.}$$



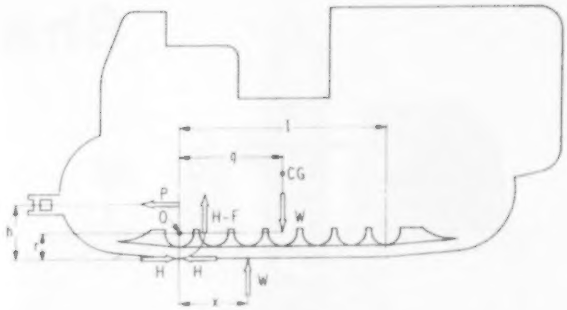


Fig. 5, above: The forces acting on a crawler tractor in operation

Fig. 4, left: Trace records showing the effect of drawbar pull and tractive resistance on load distribution along the length of the track

From equation 3, a value can now be found for $H-F$, track pull less friction:

$$H-F=\frac{W(g-x)-P(h-r)}{r}=\frac{38{,}000\times 10{\cdot}5-20{,}000\times 9{\cdot}5}{9}$$

$$\simeq 23{,}200 \text{ lb}$$

and from equation 1, the soil resistance will be:

$$R=H-F-P=23{,}200-20{,}000=3{,}200 \text{ lb}.$$

While this figure is not abnormal for soil resistance, 8·5 per cent of the tractor weight, it is interesting to compare it with the result had the weight been equally distributed over the tracks. Towing tests of this tractor over the same soil showed that the total resistance to motion was 1,500-1,600 lb, and since this would include the resistance due to track and roller friction it can be seen that the dynamic forces have more than doubled the soil resistance, even when a moderate load is pulled on what would normally be considered a strong soil On really soft soil, or when maximum drawbar pull is developed, the increase would be much greater.

Practical applications

This example illustrates the importance of vehicle dynamics in relation to mobility. It will also indicate the advantage that could be gained from a reduction in their effect on load distribution, which could be done by the use of a rational method for the determination of basic vehicle proportions. It might be argued, in the case of the conventional crawler tractor, that the dimensional characteristics have been established by the consideration of other factors and that the possibilities of variation are so limited as to be hardly worth while considering. The application of the analysis, however, will show that relatively small dimensional changes can have a considerable effect on maximum soil pressures.

The length of track contact, for instance, is obviously an important factor and, while it is generally assumed that this is always limited by steering requirements, an examination of current designs shows that this is not invariably so. As an example of the effect of increasing contact length, it can be shown that if 3 inches were added to the rear of the track on the tractor used in the tests described, the maximum soil pressures under average conditions would be reduced by 10 per cent.

Attempts to improve load distribution by adding weight to the front of the tractor do not always achieve the results expected. If the additional weight is considerable in relation to the total, as is the case when dozer equipment is fitted, the apparent improvement in distribution rarely compensates for the increased average soil pressure and the result is just a heavier tractor, instead of a more efficient one. The transference of a comparatively small proportion of the total weight from the rear to the front, however, can have a most marked effect.

If, for example, in the case of a tractor hauling a scraper, the normal rear control unit, representing perhaps 5 per cent of the total weight, were to be moved to the front, a location not without other advantages, the maximum soil pressure would be reduced by some 20 per cent and this measure could, dependent on soil conditions, increase the drawbar pull for the same weight by as much as 10 per cent.

The height of the drawbar has such a major influence on operational soil pressures that a new approach to the whole problem of coupling both towed and pushed equipment would appear to offer worthwhile opportunities for improving performance. While this subject is outside the scope of the present article its relevance will be appreciated in the light of the fact that, despite fundamental differences in the prime mover, scrapers and dozers are still attached to modern tractors in the same way as they were hitched to horses in the early part of the century.

High-Precision Production

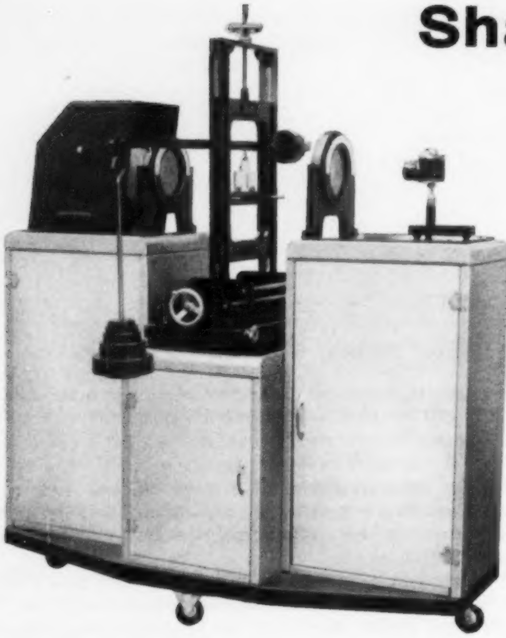
EXTREMELY close tolerances are essential in the production of bearings for inertial guidance systems and other equipment for inter-continental ballistic missiles. The experience gained in this field has enabled E.M.O. Instrumentation Ltd, of Bracknell, Berks, to devise new methods of gauging applicable to quantity production of bearings. The two essential basic features of the new equipment are motor drives and recorded readouts. All the inner and outer rings of the bearings are numbered serially, as also are the complete assemblies. Each bearing is delivered, to the customer, with documentary evidence of compliance with dimensional and functional specifications: a tally sheet, backed up by gauge traces, shows the actual dimensions of the inner and outer ring of each bearing, all accurate to within 20 millionths of an inch. Prototype quantities of 20 millionth angular-contact bearings are now available.

Extruded Copper Products

ALTHOUGH brass has been extruded since the beginning of the century, this method of manufacture is relatively new so far as application to copper and copper alloy components is concerned. A well illustrated 72-page booklet on this subject—No. 59, entitled "Extruded Copper and Copper Alloy Products"—is obtainable free from the Copper Development Association, 55 South Audley St, London, W.1.

Sharples Polariscope

An Apparatus that Facilitates Stress Analysis of Components by Photo-Elastic Methods



A Sharples Polariscope set up for use with diffused light; the model is mounted on the loading frame in a manner that permits it to be swivelled, or moved vertically or laterally

IN view of the widespread appreciation of the value of photo-elastic methods of stress analysis in the design of certain components, such as pistons and crankshafts, the recently introduced Sharples Polariscope is likely to be of interest to automobile engineers. It is manufactured by Sharples Engineering Co. (Bamber Bridge) Ltd, Hillcrest Works, Chorley Road, Walton-le-Dale, Preston, Lancs. The function of this equipment is, of course, to enable plastics models to be used for the accurate determination of the stresses that could be expected in the actual components, thereby facilitating the development of the most efficient designs.

A major advantage claimed for the Polariscope relative to others of its type is that it can operate on either the diffused light or the transmitted light principle. Each of these systems has its own merits, and the choice between them depends on the particular application. The diffused light system is more suitable for the direct visual examination of the stress patterns, because of the absence of glare effects from lenses. In addition, it enables results to be quickly assessed and provides excellent definition of the fringes for photographic purposes.

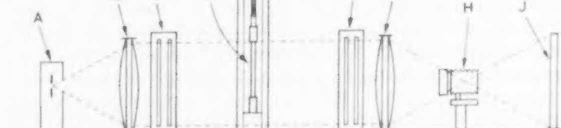
The transmission type of instrument, on the other hand, is more convenient for group demonstrations, as the image of the stress patterns can be projected on to a screen. It simplifies the drawing of isoclinics, or lines indicative of the direction of stresses, which can be traced on the screen for various angles of rotation of the polarizer and analyser. Another advantage of the transmission type of unit is the greater ease of verifying from the image that the model is correctly aligned at right angles to the light rays. Because maximum stresses frequently occur at the boundaries of components, misalignment is clearly undesirable in that it results in the appearance of double edges at two opposite boundaries of the model.

Although the Polariscope is a compact instrument, 4 ft 10 in long × 2 ft 2 in wide × 4 ft 10 in high, it embodies cabinets providing ample storage space for models and loading equipment. Its conversion from one form to the other is quickly accomplished, and both are shown on the accompanying diagrammatic illustrations. For clarity, the layout for the diffused light condition will be described first, after which the alterations necessary for the operation with transmitted light will be stated.

Alternative sources of the diffused light are provided: one is a 60 W sodium vapour lamp of the tube type, used when monochromatic light is required, and the other consists of two 150 W tungsten filament bulbs producing white light. Both are mounted in a detachable lamp-house in which is embodied the diffusing screen. Because sodium lamps should not be frequently switched on and off, a shield can be brought into action—by means of an external knob—to exclude the sodium light when the tungsten lamps are in use.

The polarizer and the analyser each consist of a Polaroid disc and a quarter-wave plate, both 5½ in diameter, mounted between sheets of glass and carried in a cast aluminium housing. Both the disc and the plate can be rotated through 360 deg in the housing, which is equipped with a circumferential scale to indicate the amount of rotation given. The polarizer is installed between the diffusing screen and the model, on the other side of which is the analyser. Beyond the analyser, at the end of the apparatus remote from the source of light, provision is made for mounting a camera.

Diagrammatic illustration of the arrangement for transmitted light
A mercury vapour lamp; B condenser lenses; C polarizer and quarter-wave plate; D loading frame; E model; F quarter-wave plate and analyser; G field lenses; H bellows unit; J projection screen

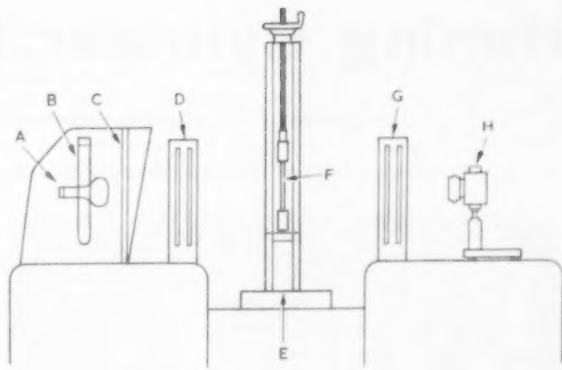


When plane polarization is required, for the examination of the isoclinics, it is not necessary to remove the quarter-wave plates, though this can readily be done. Instead, by rotating both to the appropriate position, the optical effect of one can be used to neutralize that of the other. It is then a simple matter to reset the plates when it is desired to revert to circular polarization for the study of the isochromatics, which indicate the intensity of stress.

A lever and dead weight system is employed for applying the load to the model, which is carried in a robust loading frame. This frame is designed to be equally convenient for the application of tensile, compressive, flexural and torsional

loadings. The loaded model can be moved vertically or transversely, and it can also be swivelled. A camera stand is included in the equipment; though suitable for any conventional 35 mm camera, it can readily be adapted to take one of a larger size.

The primary alteration necessary for the operation of the Polariscope as a transmission type instrument is the replacement of the lamp-house already mentioned by a platform carrying a 250 W compact-source mercury vapour lamp, a 150 W tungsten filament lamp and 6 in diameter condenser lenses of optical quality. Since the earlier remarks regarding frequent switching off and on apply to mercury vapour lamps as well as to the sodium vapour type, there is an arrangement for shielding the mercury vapour source when the tungsten filament lamp is switched on. This consists of a mirror, which performs the shielding function when it is swivelled into the correct position for directing the white light through the condenser. Fitted to the end of the instrument remote from the platform is a sliding mounting for a pair of field lenses and a bellows unit. On the bellows is a camera lens, which projects the image on to an adjustable screen; tracing paper can be fitted over the screen if the image is to be drawn.



A *tungsten lamps;* **B** *sodium vapour lamp;* **C** *diffusing screen;* **D** *polarizer and quarter-wave plate;* **E** *loading frame;* **F** *model;* **G** *quarter-wave plate and analyser;* **H** *camera*

When diffused light is to be used, the Polariscope is arranged in this form

Sharples Engineering Co. can also supply material for the manufacture of models for photo-elastic stress analysis. In addition, the company's experience in this field is fully at the disposal of existing and prospective users of its products. At present under development is a range of ancillary equipment for use with the Polariscope; this equipment includes several loading fixtures intended for special purposes.

New Hillman and Vauxhall Cars

FROM previous Rootes policy, it was to be expected that the Singer Vogue car, reviewed in the September issue of *Automobile Engineer,* would soon have a counterpart in another of the group's ranges. This expectation has been fulfilled by the introduction in October of the Hillman Super Minx saloon. Just as the Vogue does not supplant the Gazelle, so also is the Super Minx additional to the existing Hillman range.

The unitary structures of the Vogue and the Super Minx are basically identical, from which it follows that the wheelbase and front track of the latter are respectively 5 in longer and 2½ in wider than are those of the Minx 1600 vehicles, and the occupants have increased space. However, the Super Minx differs considerably in its frontal appearance from both the Vogue and the other Minx models: it has a wide, shallow and horizontally slatted grille, flanked by a single headlamp on each side. The sidelamps are above the headlamps, which are mounted lower than is customary.

There are no important differences between the Super Minx and the Vogue in respect of the engine, the alternative gearboxes and the suspension systems. In the transmission, though, a change has been made to the rear universal joint of the propeller shaft. It will be recalled that, on the Vogue, this joint is of the orthodox, needle roller bearing type, but incorporates a Metalastik rubber sleeve type coupling; in contrast, the Hillman model has a Metalastik joint embodying four pins and spherical rubber bushes. This change, incidentally, results in the elimination of a grease nipple, leaving only three on the entire vehicle.

Another new car of a derivative nature is the Vauxhall VX Four-Ninety, which has the same basic specification as the Victor, described in last month's issue of *Automobile Engineer.* However, the power output of the engine has been increased substantially, the four-speed all-synchromesh gearbox is standard equipment, and the front brakes are of the disc type. The aim of the Vauxhall engineers has been to ally the good qualities of the Victor with an even livelier performance and a high degree of refinement.

Two main steps have been taken to increase the output of the engine. First, an aluminium cylinder head, having modified combustion chambers, replaces the iron head of the Victor; consequently, it has been possible to raise the compression ratio from 8·1 : 1 to 9·3 : 1. The second step was to improve the breathing at high r.p.m: this was done by modifying the cam profiles, improving the flow characteristics of the ports, and employing two Zenith downdraught carburettors instead of one; the inlet manifold is now of the water heated type.

As a result of these changes, the gross power output has been raised from 56·3 b.h.p. at 4,600 r.p.m. to 81 b.h.p. at 5,200 r.p.m, an increase of 44 per cent. The torque, too, has risen by just over 6 per cent, from 85·6 lb-ft at 2,200 r.p.m. to 91 lb-ft at 2,800 r.p.m, still quite a moderate speed for an engine developing nearly 54 b.h.p/litre.

Although the increase in torque is not great in itself, the VX Four-Ninety is likely to be driven harder than the Victor, so the latter's 7¼ in diameter clutch has been replaced by one of 8 in diameter, and of correspondingly increased friction area. There is no change in the gear ratios, but the new car has the 4·125 : 1 final-drive ratio of the Victor estate car, instead of the 3·9 : 1 reduction of the Victor saloons. This lower ratio has been adopted because of an increase in wheel rim size from 13 in to 14 in.

To improve the handling characteristics at high speeds, the springs of both suspension systems are stiffer than those fitted as standard to the Victor saloons: at the rear, the export type rear springs are employed, whereas the coil springs of the front suspension are common to the estate cars for the home market. The Lockheed 10½ in diameter disc brakes on the front wheels incorporate shields to exclude dirt and moisture; they have a total swept area of 292·4 in^2 and are of the self-adjusting type. Since the pads each have an area of 5 in^2 and a thickness of ⅜ in, they should have an amply long life.

Individual front seats, which provide a measure of lateral support, are a standard feature, and the handbrake lever is mounted between them. A fresh-air heater and demister unit is included in the specification. The facia panel carries a tachometer, an oil pressure gauge, and an ammeter, as well as a speedometer of the circular type and a fuel gauge.

Honing Cylinder Barrels

Special Twin-spindle, Semi-automatic Machine Developed by Delapena & Son Ltd, for Italian Manufacturer of Air-cooled and Water-cooled Diesel Engines

DESIGNED to meet the specific requirements of Società Same, of Treviglio, Italy, this complete honing plant has recently been installed and commissioned. The set-up comprises:

(1) Two modified Delapena Model VHM 3C vertical, hydraulic, honing machines mounted on a common base

(2) A hydraulically operated, electrically controlled, automatic indexing, work-holding fixture

(3) A power and control unit, incorporating a hydraulic power pack for the fixture and all operating controls. Mounted on this unit are the twin automatic air-sizing control instruments

(4) A coolant collection tank and pump unit

(5) A coolant clarifier, refrigerator, and recirculation unit.

The power and control unit and the clarifier and refrigerator unit are connected to the machine and the fixture by flexible cable, conduit, and hydraulic hose, and can be situated in any convenient, adjacent position.

Model VHM 3C honing machine

This is the latest version of a widely used type of machine having a basic design that has been developed continuously by Delapena and Son Ltd, Tewkesbury Road, Cheltenham, Glos, and proved over a number of years. Recent design improvements incorporate new methods of drive and control which make the machine particularly adaptable for use in automatic or semi-automatic production lines, and with automatic size control. Although suited to large production runs when used with automatic fixtures and size control, the Model VHM3C in its standard form has simple, accessible controls and provision for rapid, easy changes of tooling. These features, coupled with the variety of sizes of components that can be accommodated and honed, make the machine equally suitable for small batch and even "one-off" production. Some of its main features are:

Stroke—steplessly variable up to 30 in

Capacity (bore)—1 in to 6 in diameter

Capacity (length)—up to 24 in

Rotational speeds—steplessly variable, 50 to 400 r.p.m.

Reciprocating speeds—steplessly variable, up to 10 in/sec

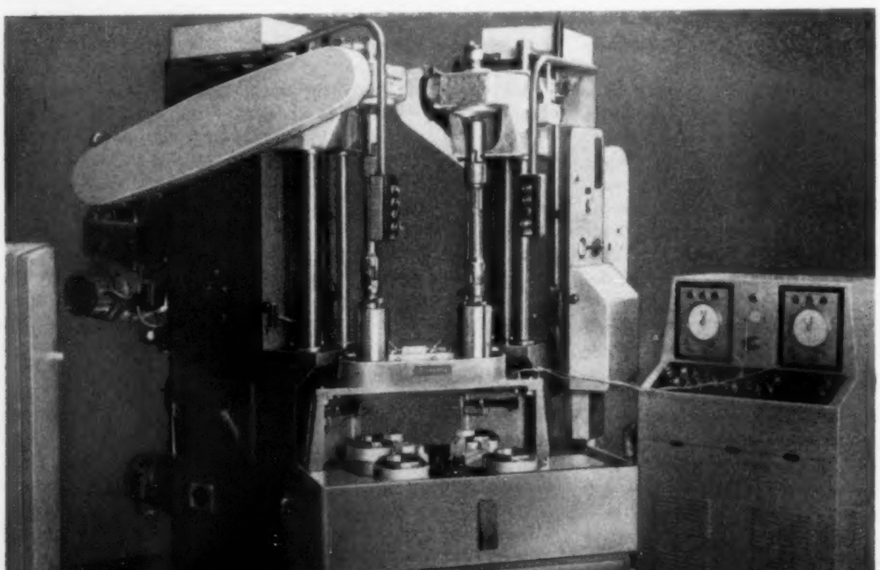
Stone pressures—precisely controllable to ensure consistent finish to specified limits

Overall height—90 in

Throat—9½ in on standard machine. Where extra large components have to be accommodated the machine can be supplied fitted with a larger gearbox giving a throat of 14½ in.

Operation

The fixture has four component stations pitched at 90 deg around the hydraulically driven, indexing table. Two adjacent stations are under the honing spindles, while the other two are available at the front of the fixture for loading and unloading. Rotation of the table is anti-clockwise. If single-operation honing of two components at a time is required it can be set to index 180 deg. This application, however, calls for roughing and finishing operations on each component. The table indexes 90 deg, presenting a newly



Delapena special machine for rough-honing and finish-honing the bores of diesel engine cylinder barrels, with automatic air-sizing control incorporated in the cycle

loaded component to the right-hand honing machine and transferring a rough-honed component to the left-hand machine for finish-honing. At each honing station a hydraulic jack then raises the component and holds it clamped against a bridge piece throughout the honing cycle.

When both components are clamped in position, the honing cycle is initiated automatically and the honing heads descend through guide sleeves into the components. At the bottom of the first stroke the honing stones are expanded by hydraulic pressure and hone rotation commences. Honing then proceeds independently at the two stations, each honing machine being individually controlled by it own automatic sizing device until a predetermined diameter is attained. On reaching size, stone pressure is released, rotation is automatically stopped, and the honing head is withdrawn from the bore. Clamps are not released until both heads are withdrawn. The components are then lowered and the table indexes through 90 deg. Provided that another component has been loaded in the next free station, the honing cycle is then repeated.

Power and control unit

In the power and control unit a hydraulic power pack occupies the lower part of the cabinet. The main control panel and electrical equipment controlling the operation of the honing machines, the fixture, and the automatic sizing dials are mounted in the upper part of the cabinet. The power pack is a Keelavite unit which supplies the hydraulic power to operate the indexing and clamping fixture. Power is obtained from a gear pump driven at 1,000 r.p.m. by a 1 h.p. electric motor and supplying oil to the clamping cylinders at a maximum pressure of 500 lb/in^2, governed by a relief valve. Actuation of the clamps is controlled by a solenoid-operated valve in the fixture.

A supply of oil at a maximum pressure of 150 lb/in^2, controlled by a separate relief valve, is provided for the hydraulic cylinders actuating the indexing table. The two sizing units are connected independently to the gauging plugs by small-bore flexible pipes.

Automatic size control

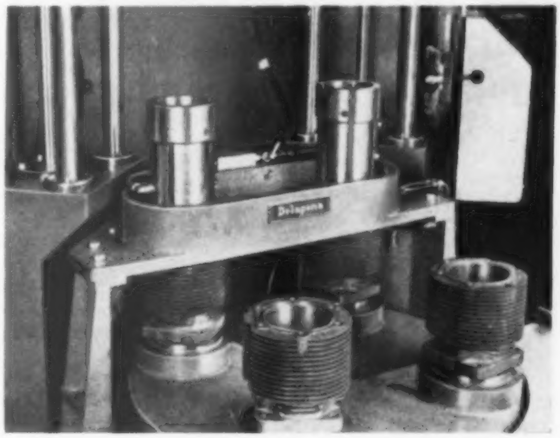
Developed by Delapena & Son Ltd. in conjunction with Teddington Industrial Equipment Ltd, the system of automatic air gauging fitted makes use of clean, dry, compressed air at between 60 and 150 lb/in^2 and an electrical supply at 230-250 volts or 110-115 volts, single-phase, 50 c/s. In this duplicated installation, each set of equipment consists of:

(1) A hardened steel gauging plug having three radial nozzles fed by an air supply from a control box. The plug rides on a bronze bearing on top of the honing head and is guided into the workpiece by a sleeve at the honing station. It is prevented from rotation by three lugs which slide in slots in the guide sleeve.

(2) The control box, which feeds up to 2 ft^3/min of compressed air to the gauging plug, contains two electro-pneumatic relays. These respond to pressure variations arising from alteration in the diameter of the bore in the workpiece as it is being honed. The electro-pneumatic relays operate indicator lamps and remote control switches.

The sizing plug cannot enter the bore until the diameter is honed out to approximately 0·004 in under size. Initially, therefore, at each down stroke of the hone, the plug rests on top of the component, the air flow from the nozzles is unrestricted, and a red indicator lamp is illuminated. When the bore reaches approximately 0·004 in under size, the plug enters the bore with each down stroke of the hone and a circuit is automatically completed by which the red lamp is extinguished and an amber "undersize" lamp is illuminated. At the same time, the control circuits are readied for the "size" signal. On reaching size, the green "size" lamp lights up and the honing head is withdrawn from the work.

In addition to the size signals given by the coloured indicator lamps, a continuous visual check on the rate of stock removal is available on a large dial operated by the air pressure and graduated over a range of 0·005 in by increments of 0·00025 in. This dial is used normally only during



Work station of twin-spindle machine with automatic indexing fixture

setting-up or checking and can be switched out of operation during production.

Coolant filtration and refrigeration

Honing-coolant fluid is fed into the guide sleeve at each work station. After cooling the honing head and component, it drains on to the worktable and thence into a collection tank at the rear of the fixture, where the heavier swarf is deposited by sedimentation. A pump mounted on top of the collection tank pumps the fluid to the separate clarifier and refrigerator unit.

In the clarifier and refrigerator unit the fluid passes through a Philips Magna Drum magnetic clarifier, where the remaining particles of swarf are extracted, and then into a refrigeration tank holding approximately 30 gal. The refrigerator evaporator coil is submerged in the honing fluid and cools a throughput of 4 gal/min up to 3 deg F. The system is thermostatically controlled to maintain a temperature of 60 deg F. Cooled fluid is returned to the fixture by a separate pump in the clarifier and refrigerator unit.

Production data of the specific application are as follows:

Components—Cylinder barrels for air-cooled and liquid-cooled Diesel engines
Material—Cast iron
Bore—4·5669 in dia
Length—9·8425 in
Diameter (fine bored) before rough honing—0·005-0·007 in under size
Diameter (rough honed) before finish honing—0·0015 in under size
Final diameter—4·5669 ± 0·0005 in
Final tolerance on roundness— ± 0·00025 in
Final surface finish—6-8 micro-inch
Honing stones (roughing) — diamond, metallic bond, 120/140 grit
Honing stones (finishing)—silicon carbide, 320 grit
Production rate—25 components per hour is the required rate but a production rate well in excess of this can be achieved. The machine is at present set up for a 70-sec operating cycle, to fulfil the Company's current requirements.

Up-stroking Hydraulic Press

A New, Versatile Sack and Kiesselbach Model for Coining, Deep-drawing, and Extrusion

LONG known for its range of hydraulic cold-hobbing and coining presses, the West German firm of Sack and Kiesselbach G.m.b.H, of Düsseldorf, has recently added a new and versatile press to its manufacturing programme. It was first announced, and was demonstrated, at the International Machine Tool Exhibition at Hanover, West Germany, this year. Conforming to the builder's usual practice, the new press is of the up-stroking type.

Since it had been designed specifically for coining, deep drawing, and the extruding of light and relatively large components, it differs in a number of features from earlier models. A bed area larger in proportion to the press tonnage was needed than was customarily provided on the range of standard cold-hobbing and coining presses. Other features required to be incorporated were a positive return action for the ram, and an automatic ejector mechanism.

Maximum capacity of the new press is 250 tons. To meet the requirements of the extended range of duties, the dimensions of the bed are 29 in × 29 in, and daylight through the press is 23 in. The ram stroke is 15 in. Power exerted on the ram return stroke and by the ejector is 6 per cent of the selected working pressure. Rapid approach speed of the ram is at the rate of 3 in per second. Working speeds are arranged at rates of 0·4 in for pressures up to 50 tons and of 0·1 in at pressures exceeding 50 tons. Return speed of the ram is 4 in per second.

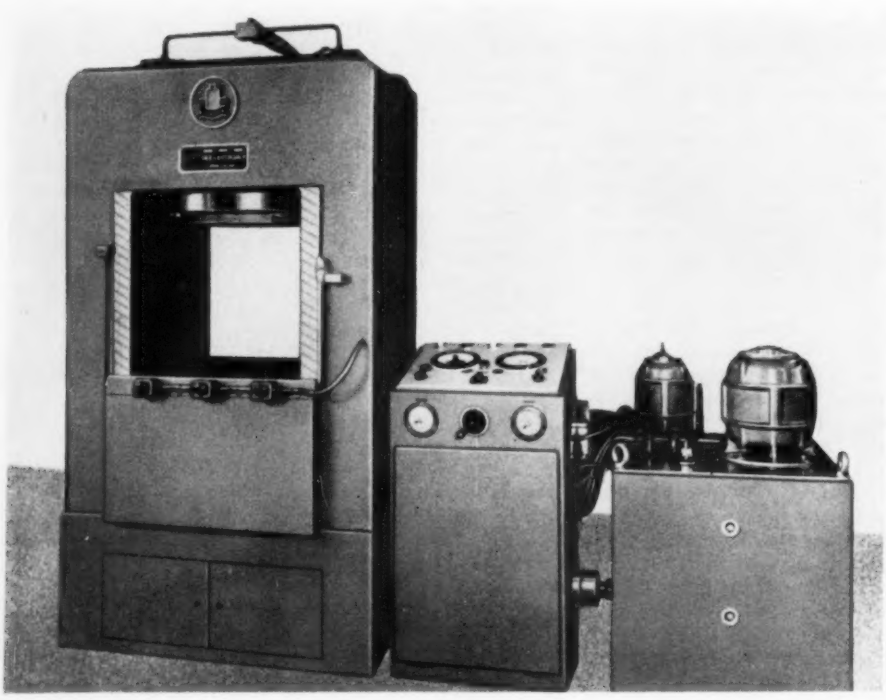
Main guideways for the bed, inside the press uprights, are protected by metal, telescoping guards. The piston is also shielded throughout its travel by guards attached to the front and the rear of the bed. Ram return, ejection, and the return of the ejector are automatically operated in the press cycle. An emergency stop button is provided to halt the press at any point in the cycle.

Operating controls are housed in a free-standing console located conveniently adjacent to the press. The hydraulic power pack is also a self-contained unit that can be independently sited. To facilitate setting-up operations, the ram can be inched and stopped at any point in its travel. Two switches must be operated simultaneously to close the press.

Approximate weight of the new press, complete with control unit and hydraulic pump unit, is 10 tons. No special base or site preparation is necessary when installing the press. Rockwell Machine Tool Co. Ltd, of Welsh Harp, Edgware Road, London, N.W.2, are the selling agents in the United Kingdom for Sack and Kiesselbach products.

A Paper on Diesel Engines

OF THE FIVE forthcoming papers in the 1961/62 session of the Diesel Engineers and Users Association, one should be of interest to automobile engineers. It is entitled "Reconditioning High-Speed Automotive Diesel Engines" and is to be presented by J. W. Wicks, of the London Transport Executive. The meeting will be held at 2.30 p.m. on Thursday, 18th January 1962, at the Institute of Marine Engineers, Mark Lane, London, E.C.3. Advance copies of the paper can be obtained, 14 days before the meeting, on application to the Secretary of the Diesel Engineers and Users Association, 18 London Street, London, E.C.3.



Sack and Kiesselbach 250-ton up-stroking hydraulic press for coining, deep-drawing and light extrusion operations

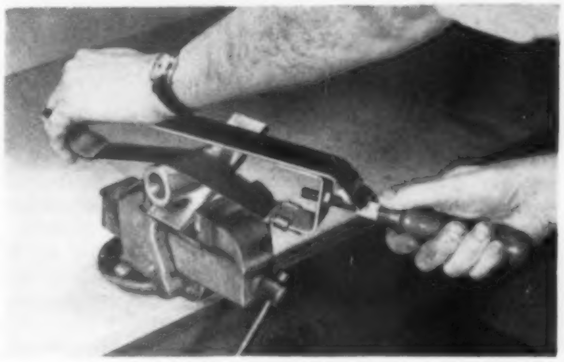
Surface Finishing of Metal Bodywork

Abrasive Materials and Tools Used in Current Practice to Reduce Manual Operations and Lessen Production Time

IN the production of motor car bodies from a welded assembly of sheet metal pressings it is essential that the surface of the structure should be as smooth and as free from blemishes as possible. The paint finish will not conceal any contour irregularity or surface imperfection and may, in fact, even accentuate it. Traditionally, it has been customary to remove waves, depressions, or "dings" by hammering, then redressing by filing and discing, and finally rubbing down manually with sheet abrasive. Such operations are performed by skilled personnel and are relatively costly and time consuming. On occasion, they may exceed the scheduled time allowance and retard the flow of a production line.

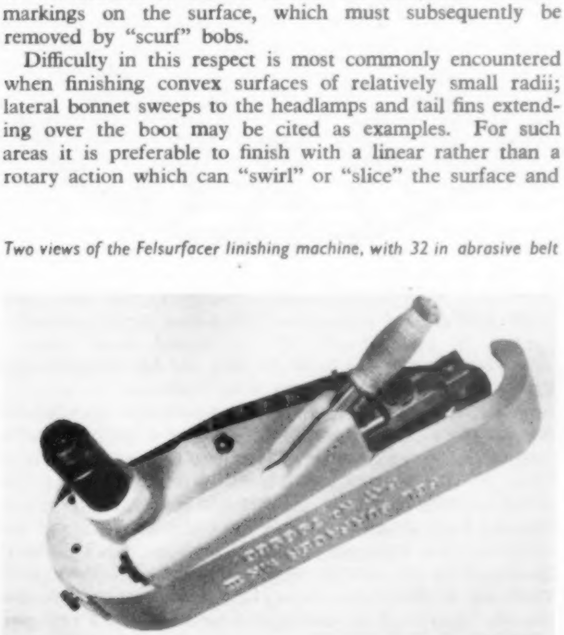
Discing the surface with a power-driven tool or a flexible-shaft drive is, of course, well known and widely practised. In skilled or well-experienced hands it can be satisfactory providing suitably chosen backing pads are used. However, in the absence of skill or care it can easily leave "swirl" markings on the surface, which must subsequently be removed by "scurf" bobs.

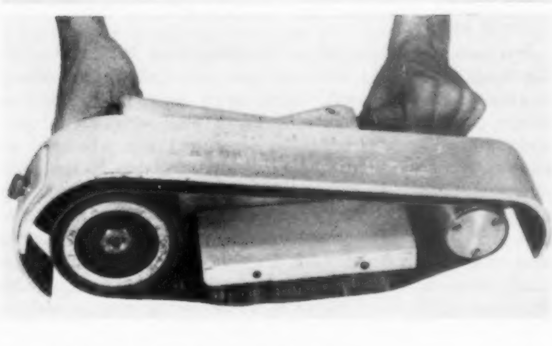
Difficulty in this respect is most commonly encountered when finishing convex surfaces of relatively small radii; lateral bonnet sweeps to the headlamps and tail fins extending over the boot may be cited as examples. For such areas it is preferable to finish with a linear rather than a rotary action which can "swirl" or "slice" the surface and roughen the grain of the metal. In short, a linishing operation is desirable, with a continuous abrasive belt running unidirectionally.



This adjustable hand tool is effective on both convex and flat surfaces

Two views of the Felsurfacer linishing machine, with 32 in abrasive belt

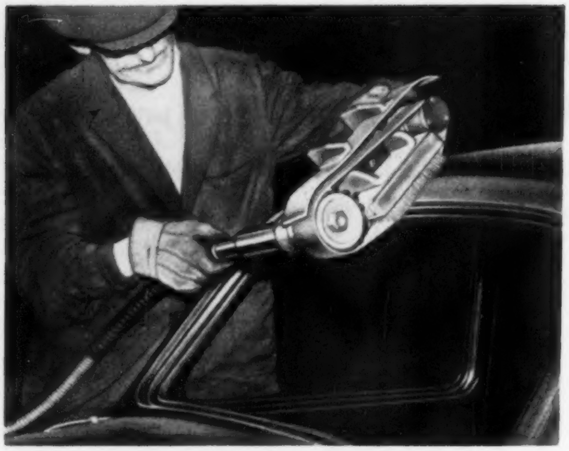




As might be expected, these problems have exercised the minds of engineers immediately concerned with body production and have led to the design of tools specially adapted to overcome them economically. Excepting the Portabelt attachment, those described in this article are manufactured and marketed by Abrasives and Equipment Ltd, 118 Constitution Hill, Birmingham, 19; which company also stocks and distributes the abrasive materials to which reference is made.

The Felsurfacer portable linishing machine was invented by W. R. Boyell and developed by Fisher and Ludlow Ltd. It comprises an elongated body frame of light alloy, at one end of which is mounted a spindle carrying a driving pulley and a coupling for attachment to a $1\frac{1}{2}$ h.p. flexible-shaft drive unit. The return pulley for the $32 \text{ in} \times 2 \text{ in}$ belt is supported on the end of a shaft, keyed to prevent rotation, which is slidable in the frame and constrained by a compression spring to tension the abrasive belt. Screw adjustment is provided to enable the spring loading to be varied to suit the requirements of the work undertaken. To facilitate changing of belts, the shaft can be depressed against the spring and held in a retracted position by a trigger-type latch engaging in a groove formed in the shaft. A pivoted mounting is arranged for the return-pulley spindle on the end of the shaft and a fine-pitched screw adjuster enables the angle of the spindle to be set, relative to that of the driving pulley, to ensure perfect tracking of the belt.

An important feature of the machine is the provision of a resilient support for the free run of the belt. For this purpose a rectangular-shaped brush is secured rigidly in a support bracket formed on the main frame. When in position, with the bristles of the brush engaging the inner (backing) surface of the belt, the line of the operative run of the belt is displaced from the straight to a convex configuration. To reduce friction between belt and bristles, the backing of the abrasive belt may be coated with a film



A Felsurfacer linisher finishing the front of a roof panel above the screen

of polyvinylchloride. Alternatively, the pressure of the bristles may be transmitted through a stationary thin, flexible sheet of polyvinylchloride.

Brushes can be supplied suitably tufted for different applications. They are all closely tufted—16 knots per square inch—to give adequate support to the belt whilst allowing it to conform to either a concave or a convex surface. Animal bristles, or horse hair, are desirable but other fibres may be employed. It has been found that the projecting length of the bristle from the wooden back of the brush should be in the range of $\frac{3}{4}$ in and $1\frac{3}{4}$ in.

Linear operating speed should be chosen between 2,000 and 6,000 ft/min. At a speed below 2,000 ft/min abrasive action is ineffective and at speeds in excess of 6,000 ft/min the temperature of both the abrasive belt and the surface of the work is likely to rise to too high a value. The driving pulley is of the heavy duty, solid rubber "flexer" type of Flex-bob, which in operation expands under centrifugal force and thereby establishes driving contact with the belt.

For work on small areas, or in difficult locations, the firm produce a linishing hand tool. The file-type handle is rotatable in a bushing secured to the angled end of a flat steel strip frame over which an abrasive tape is drawn. At the opposite end of the frame the strip is turned through more than 180 deg and the tape extends to the angled end of a sliding member, also of flat strip. Quick-acting sliding clips secure the abrasive tape to both the main frame and the slider. The screwed shank of the handle is threaded into the slider and rotation of the handle tensions the tape, after the manner of a bow-string. A holder can be provided on the handle bushing to carry a small roll of tape for rapid renewal of the operative length. While normally used on the unsupported run of the abrasive, for curved surfaces, inversion of the tool presents a supported run of abrasive for smoothing flat surfaces or for the rapid removal of high spots.

Two operators using Felsurfacer linishing tools on the front wings of a body

Bobs for general use—stock removal, polishing and finishing according to the grade of abrasive band fitted—have a solid body of glass fibre reinforced plastics, tapped to receive a $\frac{5}{8}$ in diameter, 11 t.p.i, straight spindle. The peripheral surface is formed with longitudinal, contoured grooves to admit the limbs of adjacent, channel-section, rubber "flexers", as illustrated in the line drawing. When fitted with an abrasive band and rotated, either by an electric or pneumatic hand tool or a flexible shaft drive, the removable interchangeable flexers extend under the influence of centrifugal force and hold the band securely in position. When applied to the work, the flexers give a firm but flexible cushioning effect which enables the operator to produce a satisfactory finish on concave or convex contours and on flats with a minimum expenditure of production time. Safe rotational speeds are from 6,000 to 9,000 r.p.m.

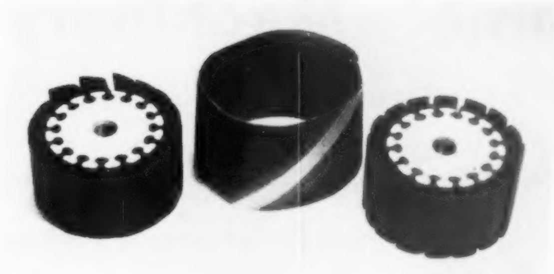
Mounting of renewable rubber flexers in reinforced plastics Flex-bob

The standard dimensions of the bob are 4 in diameter and 2 in wide, but a range of sizes is available.

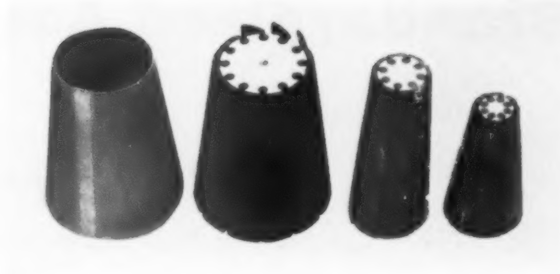
Variants of this design of bob, specifically intended for stock removal duties, are fitted with solid rubber, single-limbed flexers. Elements of this type are a feature of a range of conical bobs, also bored and tapped for a $\frac{5}{8}$ in diameter straight spindle. Commonly used sizes, for which abrasive band cones are readily available, are $1\frac{3}{4}$ in and 1 in diameter $\times$ 3 in long, and 3 in and 2 in diameter $\times$ $3\frac{3}{4}$ in long. In the event of damage, flexers of either hollow or solid types are readily replaceable. It is necessary only to slide the old one out of its groove and then slide in a new one.

Current practice

For car body assembly and rectification "in the white", the range of suitable abrasives and coated-abrasive products is very wide, and careful selection is desirable in order to obtain the desired quality of finish with economy of cost and time. The abrasive materials most commonly used are aluminous oxide and silicon carbide, available in the form of sheets, discs, tape rolls, bands, cones, and belts. Backings may be cloth, fibre, or paper, and the bonding agent either glue or resin. Machines used are electrical or pneumatic disc sanders provided with suitable backing pads, flexible shaft machines with appropriate attachments, and portable linishing machines. In general, operating speeds are not



Flex-bobs are fitted with either solid or hollow renewable rubber flexers



Conical Flex-bobs and coned bands are available for finishing awkward radii

less than 6,000 ft/min and not higher than 7,500 ft/min on ferrous metals. For non-ferrous metals, such as aluminium and lead, the surface speeds should be much lower, say 4,000 to 5,000 ft/min.

Probably the most widely used product is aluminous oxide abrasive, resin-bonded on a vulcanized fibre disc. The most common size is 7 in outside diameter with a $\frac{7}{8}$ in diameter fixing hole, and the grit size, according to the nature of the work, may be 36, 60, 80, or 100. These are used at disc speeds of 5,400 r.p.m. For some applications it may effect a substantial economy to use a 9 in diameter disc and, as maximum wear occurs at the peripheral margin, to cut the disc down successively to 8 in, 7 in, and 6 in diameter. Should this practice be adopted the disc speed, at diameters greater than 7 in, should be lowered to 4,500 r.p.m.

The choice of backing pads for abrasive discs is most important in respect of density and diameter. Both of these factors will affect disc performance and flexibility. Today, the trend is to use discs having a fibre backing 0·025 in thick for contour work, instead of the usual 0·030 in thick fibre backing. The thicker backing is regarded as the standard for use in the removal of welds, surface defects, tool marks and surface ripples. It is common practice after discing to use scurf bobs to eliminate swirl marks left on panels that are subsequently to be painted.

Abrasive bands and belts, used over a flexible bob, have a linear action instead of the rotary action of a disc. Consequently, the need to use scurf bobs in a follow-on operation is obviated. For work on flat panels and on contours on wings and roof panels they are much to be preferred. Bands and belts are cloth-backed, with grits of 60, 80 or 100 bonded with glue, semi-resin, or resin. Operation is at from 6,000 to 7,500 r.p.m.

Equipment making use of bands and belts are the Flex-bob and the Felsurfacer, already described, and the Portabelt produced by the Carborundum Company Ltd, of Manchester. This attachment is designed for use with a flexible-shaft or portable grinder and can be fitted to tools by Gilman, Wolf, Black & Decker, and others. A 4 in diameter × 2 in wide, helically grooved, rubber-tyred contact wheel is mounted on the grinder spindle and the return pulley is carried on the end of a suitable framing secured to the end of the grinder gearbox in place of the standard wheel guard. The pulley rotates on a ball bearing in an eccentric mounting which is spring-loaded to control the tension of the 24 in × 2 in abrasive belt.

All these items are capable of stock removal at a reasonable rate and can produce a good surface finish providing a key for a paint coating. The Portabelt is mostly used for convex surfaces while the Felsurfacer, by virtue of its brush support, can be employed on convex, concave, and also flat surfaces. An abrasive band on a Flex-bob is effective for rapid stock removal and can impart a good finish.

Conical bobs with abrasive cones of 40, 60, or 80 grit are generally used on pneumatic tools, at speeds of 6,000 to 7,000 ft/min. They are excellent for grinding radii in difficult locations.

Abrasive cloth sheets, usually measuring 9 in × 11 in and having grits of 40, 60, or 80 grade, are used by hand for numerous minor operations and are particularly useful for reducing the rough surface condition of work after treatment with a "Dreadnought" milling file.

Paint shop applications

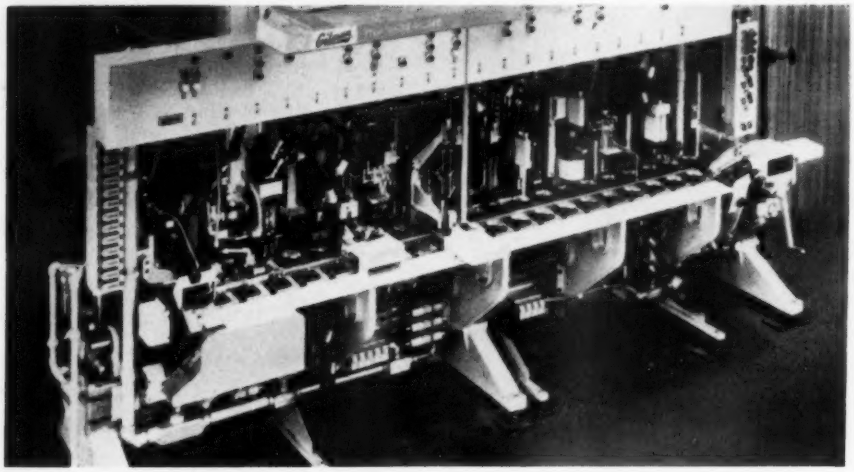
In the paint shop, abrasive paper sheets of the standard 9 in × 11 in size have silicon-carbide grits of many different grades from 180 to 320 bonded by waterproof resin. They are used in the hand for rubbing-down and flatting operations, with a copious supply of water. Coarser grits are chosen for use on reciprocating sanders, also under wet conditions. However, the most commonly used grit for wet operations is 320 grade. For dry "nibbing" operations a light-weight, glue-bonded, silicon carbide paper is preferred.

The illustrations showing the Felsurfacer in use in the workshop are reproduced by courtesy of Fisher and Ludlow Ltd, Albion Works, Kingsbury Road, Birmingham, 24.

Portabelt attachment shown in use mounted on a Wolf GQ6 portable grinder

Standardized Assembly Machinery

Basic Units in the Gilman Transferline and Indexomatic Range Can be Built Up to Form Assembly Machines for a Variety of Products



On this 22-station Transferline machine, boot locks are being assembled. The platens move to the right along slideways at the front of the machine, and receive the first component, a pressing, from the small hopper in the centre. At the far end, they are transferred to parallel slideways to the rear, and move in the reverse direction past a row of devices that add other components and build them into a complete assembly, which is discharged at the chute on the left. Among these devices are machines that check the presence and dimensional accuracy of components, and the ability of the finished assembly to function correctly. Any component that is faulty is passed along the machine and discharged without being assembled; above the machine are lights to indicate faulty devices

IN general, of all the operations that go towards the manufacture of any multi-part product, the assembly operation is the most difficult one to which to apply the principles of automation. Sometimes, the component parts of an assembly or sub-assembly are so varied in size, shape and weight that they can conveniently be put together only by hand. The purchase or development of machinery for automatic assembly operations is usually beyond the resources of a small firm, particularly one engaged in the manufacture of a wide variety of products. Although larger concerns can afford to develop and build their own specialized machines for the purpose, they may well be faced with periodic design changes that militate against such a course of action.

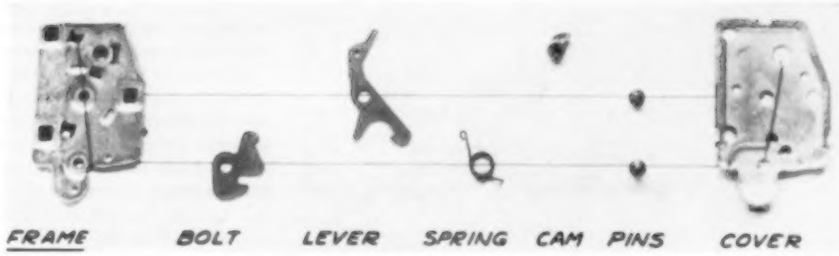
The most logical method of overcoming these limitations is by means of a range of automatic assembly machines incorporating standardized, interchangeable units; the manufacture of such equipment is, of course, cheaper than that of specialized machinery, and also there is greater scope for a rapid changeover during re-tooling at the end of a production run. Only in recent years, however, has any intensive work been done in this field. In Great Britain, Kearney and Trecker-C.V.A. Ltd, of Garantools House, Portland Road, Hove, 3, Sussex, have been manufacturing assembly machines for some time, but the scope of these is now below current industrial requirements. To obviate the long and costly development programme that would necessarily precede the introduction of new and more complex equipment, this company has, therefore, arranged to market the existing products of the Gilman Engineering & Manufacturing Co, of Janesville, Wisconsin, U.S.A, which specializes in the design and manufacture of machines for automatic assembly.

Two basic types of equipment are produced by the Gilman organization: they are the Transferline, which is designed for in-line operation and high-volume production, and the Indexomatic, a rotary machine for a small number of assembly operations. Gilman machines, which are built from standardized units on the *building block* principle, can be used to assemble a wide range of components, from delicate electronic units to relatively heavy automobile parts. They are now being widely used by industry in U.S.A, and motor vehicle manufacturers are finding them particularly useful for the assembly of such things as door locks, distributor shafts, connecting rods, dampers and valve gear rocker arms. Automatic assembly processes can, of course, be integrated with manual or mechanized assembly, and are, therefore, highly adaptable to the simultaneous production of several variants of a basic design.

Transferline range

For each assembly or group of components there is a jig or fixture on to which the first component is placed, ready to receive later ones. The fixtures are attached to platens, which move intermittently, in a longitudinal line, past a row of devices performing operations such as loading components, peening, nut-running, soldering, gauging, lubricating, and checking torque. Beneath the slideways for the platens are reciprocating bars incorporating driving pawls; the pawls are set at the same pitch as the platens, and move them forward through one pitch at the end of each working cycle.

These components of the lock of a boot lid are well suited to automatic assembly. Among the operations included in the programme are application of a small amount of grease, orientation of the cam, preloading of the spring prior to positioning, and peening of the pins to complete assembly of the lock



When a platen reaches the end of the row, it is moved over to a parallel line travelling in the reverse direction. On the return line, the finished assembly is unloaded, and another first component is placed on the fixture. After it has been reloaded, the platen travels to the end of this return line, and then is transferred to the working line, to begin the next cycle of assembly operations.

The basis of each machine in the range is a standard bed, which is a rectangular-section cast-iron beam, 8 in wide by 9½ in deep. In the top and side faces are T-slots for mounting the assembly devices and their associated machinery. Outrigger brackets supporting the dual slideways for the platens are mounted on the front face; the slots in the other faces are for mounting standard reciprocating mechanisms, loading hoppers, rejection chutes and support brackets.

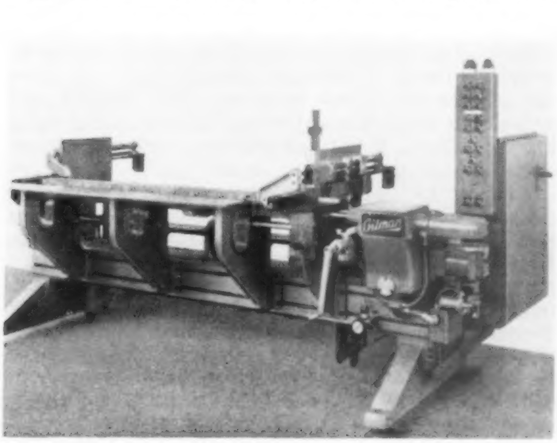
At one end of the bed is the drive unit—consisting of an electric motor and a worm reduction—for a 2 in diameter camshaft that extends along the machine. Complete synchronization of all the assembly, loading and transfer mechanisms is assured by the fact that they derive their motion from this one camshaft; transfer movements of the platens are controlled by a single bell-cam, and plate cams are used for all other devices. Also incorporated in the basic machine are the reciprocating bars for the longitudinal transfer movements of the platens, a control unit for the devices that incorporate pneumatic operation, a centralized lubrication unit, a hand-operated crank for use during setting-up, and a cabinet containing the electrical control equipment.

The whole assembly is mounted on standard, wide-base legs, each having a small amount of vertical adjustment for levelling, and the slideways for the platens are at a convenient height for supervision and maintenance. The pitch of the platens, and therefore the distance of their intermittent movements, can be either 6 in or 9 in. Work stations can be sited at any point along the machine, their spacing being in multiples of 6 in or 9 in, and obviously depending on the size of the components being assembled and the nature of the operation involved.

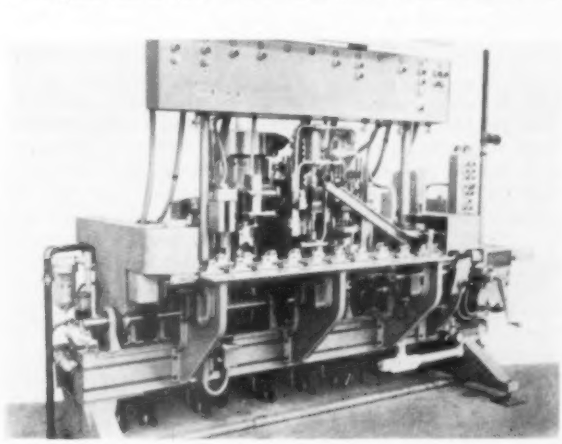
Standard beds are available in a range of lengths from 10 to 24 pitches of the platens, in steps of 2 pitches. The overall length of the 10-station machine of 6 in pitch is 9 ft 1 in, and there is an addition of 12 in to this figure for each increment of 2 pitches; the overall length of the corresponding 9 in pitch bed is 11 ft 6 in, and the increments are, of course, 18 in. Beds with pitches of 18 in and 30 in can be made, to special order. For the 6 in Transferline machines an overall height of 5 ft 2 in is quoted; the overall width, including the control cabinet, is 5 ft 7 in, and the platen slideways are 3 ft 2 in from the floor. The corresponding figures for the 9 in series are respectively 6 ft 3 in, 6 ft 3 in and 3 ft 8 in.

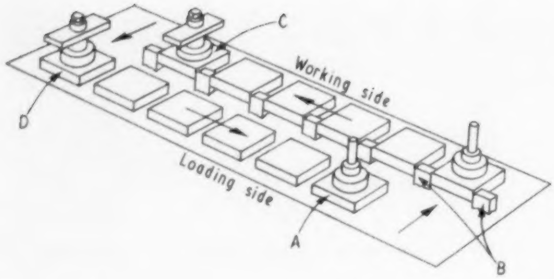
As already mentioned, valve gear rocker arms are typical of the products currently being assembled on Transferline machines in the U.S.A. The following sequence of operations is carried out on a rocker arm made in both left-hand and right-hand versions: a random group of components is loaded manually on to a storage bank; each arm is picked up and lightly lubricated; the adjusting screw is hoppered, oriented and run in to a tapped hole in the arm, to a pre-set depth; the arm is turned over for application of a nut, and the nut is run on; a coil spring is inserted into a plain hole, followed by a retainer and a locking pin; a 1,200 lb test load is applied, to check for flaws; the whole assembly is checked for completeness; finally, the assemblies are segregated into three categories—left-hand, right-hand and

Basic Transferline machine, which includes a rectangular section bed with T-slots, the supports and slideways for platens, the drive mechanism and camshaft, a control panel and standard feed devices



The same machine built into a 6 in pitch, 12-station unit assembling rocker arms at a rate of 1,440 per hour. Just behind the support brackets for the platen slideways is the camshaft, which controls all movements





Pawls B move the platens along one side, in alternation with those on the other. The first component, loaded at A, transfers to the working side as the complete assembly C is returned, ready for unloading at D

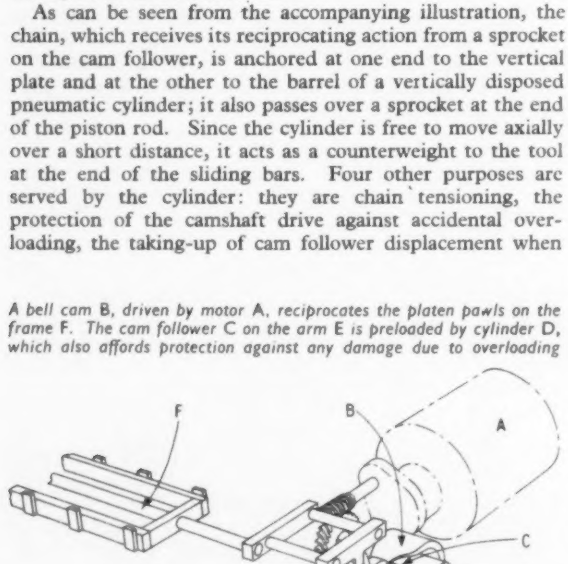
defective. This assembly work is carried out on a 16-station machine, and there are seven components in each finished arm assembly. A production capacity of 1,200 rocker arms per hour is claimed.

One of the advantages of automatic assembly equipment is that, if checking devices are required, they can be built into the machines. These devices can be designed to apply gauges for dimensional checks, feel for the presence of the last component to be loaded, verify that a part is correctly oriented, and confirm that an assembly is able to perform its designed function. The incorporation of these devices removes the chance of error that is always present with manual checking, and ensures a considerable saving of time.

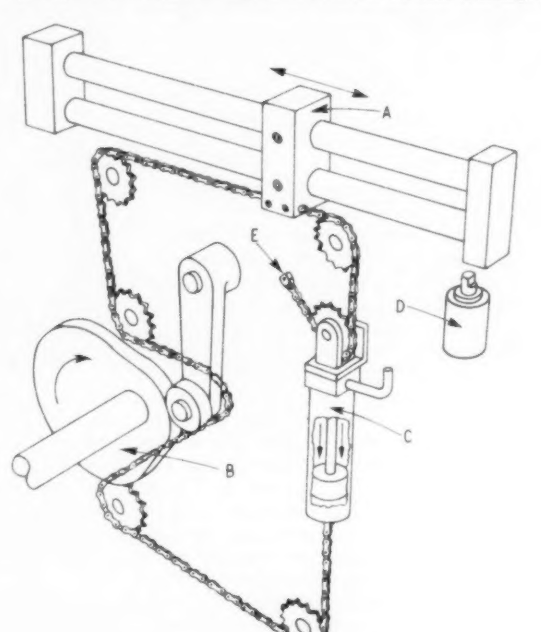
Since the great majority of the operations performed during the course of assembly involve some degree of reciprocating movement, a standard feed mechanism with reciprocating action is used with the Transferline and, in fact, with all Gilman automatic assembly machines. This mechanism is mounted on a vertical plate attached to the bed, and the linear motion is generated by a cam and transmitted by roller chain to two rigidly connected parallel sliding bars, to the ends of which is attached the tool appropriate to the operation. Each cam on the camshaft is of individual design, because each pair of sliding bars has its particular requirements of travel, dwell and acceleration.

As can be seen from the accompanying illustration, the chain, which receives its reciprocating action from a sprocket on the cam follower, is anchored at one end to the vertical plate and at the other to the barrel of a vertically disposed pneumatic cylinder; it also passes over a sprocket at the end of the piston rod. Since the cylinder is free to move axially over a short distance, it acts as a counterweight to the tool at the end of the sliding bars. Four other purposes are served by the cylinder: they are chain tensioning, the protection of the camshaft drive against accidental overloading, the taking-up of cam follower displacement when the sliding bars are temporarily and selectively locked out of action to conform to the requirements of the programme, and the maintenance of a constant axial load on the bars. The axis of operation of the feed mechanism is in a vertical plane at right angles to the longitudinal axis of the bed, but the angle of presentation of the slide bars is adjustable through 90 deg in this plane. If the programme requires that any pair of bars is locked out of action, as just mentioned, this is done by means of a small, pneumatically operated plunger at the ends of the bars remote from the tool.

A bell cam B, driven by motor A, reciprocates the platen pawls on the frame F. The cam follower C on the arm E is preloaded by cylinder D, which also affords protection against any damage due to overloading



Attached to the bars are adjustable limit stops, and also limit switches that transmit signals to indicate faulty parts or operations. The movements of the stations are electrically interlocked, so that mechanisms can be automatically brought into action or locked out, as necessitated by the programme. If one of the automatic checking devices detects a component that departs from specified tolerances, the incomplete assembly is passed along the machine without further loading or



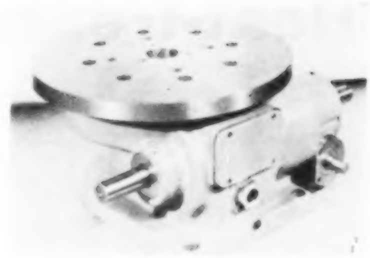
Standard feed mechanism. The chain, anchored at E, is deflected by cam B; the pneumatic cylinder C acts as a chain tensioner, an overload protection device and a counterweight to the sliding bars A, which can be selectively locked out of action by pneumatic plunger D

assembly operations being done, and is rejected at the end of the line. In the event of any pair of bars not completing its normal full travel, the machine is automatically stopped so that remedial action can be taken. The standard feed mechanisms, which have a travel of 7 in, can be used either singly or in pairs, for two simultaneous movements at one station.

At the front of each Transferline machine is a panel of indicator lights, on which there is visual indication of the complete operating cycle of each mechanism. It indicates, for each work station, the forward travel of the feed mechanism, the return travel and the loading of the component. To accommodate programmes involving families of parts, or components not common to all assemblies, simple units based on a sequential memory system are incorporated in the control circuits; by means of these units, a programme variation can be instituted by the operation of a switch, and selected stations can be brought in or by-passed. If

the variants of an assembly form only a small proportion of the total production, it may be found convenient, of course, to intersperse the automatic operations with manual ones.

One of the chief virtues of the Transferline machines is the fact that all the work stations and feed mechanisms are fully accessible from front to rear. The addition of other work stations to an existing unit is a relatively simple operation, as the connections to the camshaft, pneumatic or hydraulic lines and electrical power sources are quickly made. Because of the rigidity of the bed, no special foundations are required.



The 200 series Indexomatic turntable, one of a range of three. These units are supplied either alone or in conjunction with any of the standardized assembly equipment, they are intended for assemblies comprising only small numbers of parts

Indexomatic range

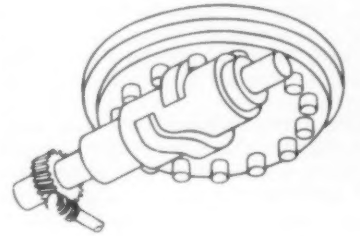
In this range, the basic unit is an indexing turntable to which the work table is attached; there are three sizes of machines in the range, and the size governs the number of fixtures that can be accommodated on the table. Indexomatic machines can be used alone, or mounted on bases provided by the user; alternatively, they can be employed in conjunction with conventional power tools. They are also available on standard bases, equipped with the normal Gilman cam-actuated mechanisms, so the customer has only to add the tooling fixtures.

Fixed to the underside of the turntable is a ring of vertical pegs, equal in number to the stations on the work table. These pegs register successively in the groove of a face cam; the configuration of this groove is such that each indexing movement occupies approximately a quarter of a revolution of the cam, the remainder being table dwell. An accuracy of $\pm 0{\cdot}002$ in, measured at the radius of the pegs, is claimed for the positioning afforded by this method of indexing.

Of the three models in the range, the 100 series accommodates work tables of up to 18 in diameter, with either 6 or 8 fixtures; the 200 series is for tables of up to 36 in diameter and carrying 8 or 16 fixtures; and the 300 series is the heavy-duty version, for tables up to 60 in diameter and with 8 or 16 fixtures. As in the case of the Transferline equipment, a standard electrical control system is available, incorporating an automatic cycle counter, a memory unit, a braked motor and various control relays. In addition to these features, a standard cam-actuated switch unit can be supplied, for the electrical timing and control of the equipment on the stations.

General considerations

The manufacturers of this equipment say that, in general, assemblies comprising between four and fifteen components are suitable for the standard assembly machines, but in special cases as few as two or as many as twenty components can be assembled. If the number of items is low, of course, the labour costs of manual assembly are also low, and a change-over to automatic assembly could only be justified by high volume production. Since, in some circumstances, the machines are automatically switched off by the presence of faulty components, another consideration is the need to supply the machines with parts of a consistently high quality. In addition, cleanliness in the workshops is very desirable, as the presence of foreign matter could affect the performance of the automatic checking devices. This cleanliness is not restricted to the elimination of dirt and swarf, but also meets the need for keeping the hoppers free of rubbish that could affect the feeding of components.



Underneath the turntable is the indexing mechanism. Each peg coincides with a work station on the table, and the configuration of the groove on the cam is such that the dwell period of the table occupies almost a quarter turn of the camshaft

The transition from manual or mechanized assembly to automatic assembly is not necessarily a smooth one. Among the problems that arise is the suitability of components to feeding by hopper; in one particular application, a small spring for a car door lock had to be redesigned because it could not properly be oriented for this method. In the operation of machines already built by the Gilman organization, the most frequently encountered problem has concerned the positioning of components. Experience has shown that gravity final feed is not sufficiently reliable, because of the variation in sizes, levels and positions of the points of contact between adjacent or mating components; most parts have, therefore, to be positively placed in position.

TESTING FOR LIGHT FASTNESS

An improved machine for testing materials for their resistance to exposure simultaneously to moisture and strong daylight has been introduced by Quarzlampen G.m.b.H. of Hanau, Germany. Previously, this firm manufactured the Xenotest instrument in which test pieces were exposed to the light that was emitted from a Xenon lamp and passed through two special glass filters; these filters were water-cooled. Attempts to improve the performance of the instrument by fitting a third filter were abandoned when it was found that this filter was affected by moisture; the decision to redesign the machine completely was therefore made.

In the new machine, which is named the Xenotest-WL, Model PL 671, air is used as the cooling medium for all three filters, and by this means the samples can be kept at a lower temperature while undergoing test. As a result of the inclusion of the third filter, the light is now an almost exact reproduction of daylight; previously there were certain intrusive wavelengths unrepresentative of normal conditions, but these have now been eliminated. The atmosphere in which samples are irradiated is humidified by spray jets and not, as before, by wicks.

Materials can therefore be tested in conditions of controlled temperature and humidity, and in light that is ten times as strong as English sunlight; simulated rain can be sprayed on the samples at selected intervals of time. Existing Xenotest machines can, incidentally, be converted to the new design. In the United Kingdom, the agent for the Xenotest is John Godrich and Company, whose address is 23 School Road, Shirley, Solihull, Warwickshire.

Heat-treated Side Frames

Die-quenching Machine Makes Possible High-rate Production of Commercial Vehicle Chassis Side Members Free from Distortion

OPERATORS of heavy commercial vehicles, spurred by fiscal regulations, continually demand reductions in vehicle weight in order to raise payloads. Concurrently, with complete disregard of logic, the need is expressed for greater chassis strength, not only to carry the increased payload but also to extend vehicle life. Such demands were met partially by the development of heat-treated side members for commercial vehicle chassis frames. These component members were produced by processes that were limited to low volume and a resulting high unit cost. Because of inherent difficulties, these processes could not be modified or adapted to low-cost mass-production techniques.

Former production method

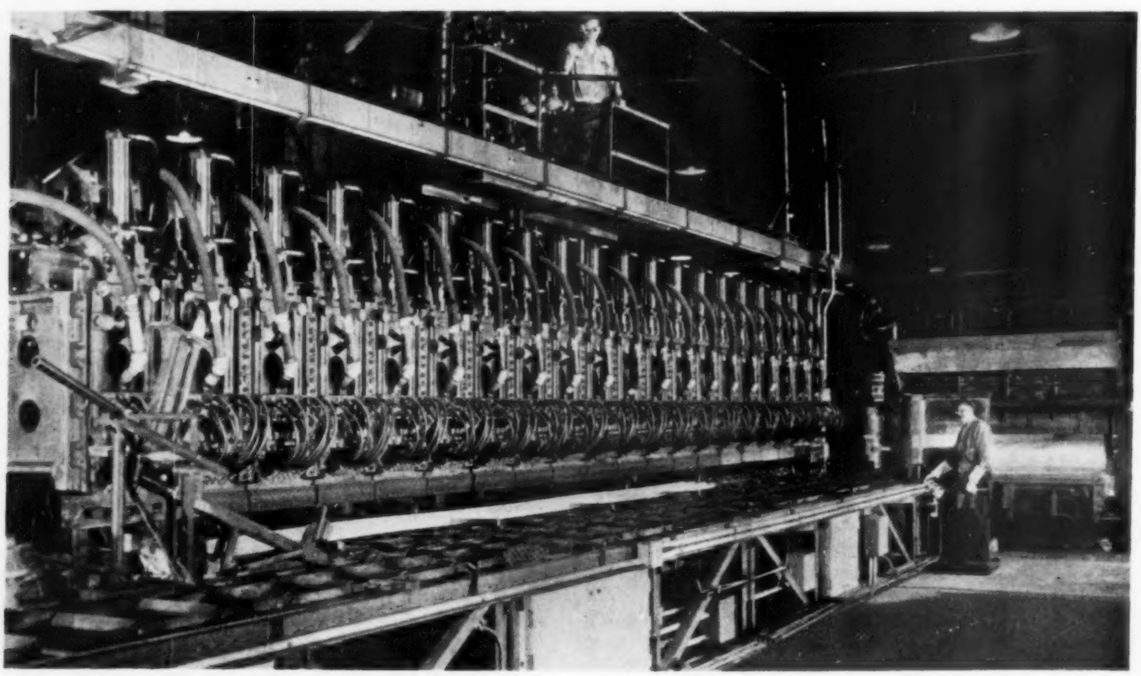
The side frames were usually heated for 30 minutes at a temperature of 1,650 deg F and were then drawn from the furnace, quenched in circulating oil, and finally tempered at 900 deg F. Alloy steels were generally used but, in order to achieve extreme hardenability, it frequently was necessary to employ a richly alloyed steel, such as SAE-8620. Each heat-treated member was given a Brinell test and if found not to be within the specified hardness range was sent back through the hardening cycle.

As a result of this method of heating and quenching, the side frames frequently were badly distorted in bend, bow, twist, and flange camber. To remedy these defects, selective hand straightening by experienced operatives was required. The first step in straightening a distorted member was to remove the bend. This was done over a short length of the component at a time. It was supported at two points and a hydraulic ram was lowered between the points. This process was necessarily repeated several times over the length of the member.

Flange straightening was done manually, a few inches at a time. Again it was necessary to make several passes up and down the length of the member in order to meet a tolerance of 1 deg between the flange and the web. Bow was removed by a method similar to that employed in rectifying the bend. The final straightening operation was the removal of twist. The hardened member behaved like a heavy torsion bar and, therefore, required stressing beyond the actual degree of distortion. The combined strength of several men often was required to remove the twist.

This method of heat-treating, quenching and straightening had a number of serious drawbacks:
1. A considerable percentage of the cost of production was made up of manual operations required to correct distortions
2. It could not be adapted for economical mass production

Machine developed by the A. O. Smith Corp. of Milwaukee, U.S.A. capable of straightening and quenching truck frame side members up to 40 ft in length



3. Most important of all, it imposed limitations on the development of full hardness potential, as well as on the uniformity of the hardness obtainable.

Approximately seven years ago, project engineers of the A. O. Smith Corporation of Milwaukee, Wisconsin, U.S.A, began to study various alternative methods of heat-treatment in an effort to reduce or completely eliminate hand-straightening operations.

Experimental machine

Based on the theory that a suitable fixture could straighten the side member while it was hot, and that the mass of steel in the fixture could be employed to act as a quenching agent, an experimental machine was built. The operating principle of the machine was simple and straightforward. The hot, channel-section member was drawn from the furnace, pulled into the machine, through its open end, and loaded into the fixture. A punch was then lowered between the open flanges of the member until it reached the bottom of the stroke. Continued pressure spread apart the halves of the divided punch until they contacted the inner sides of the flanges and web. Next, the right, or front, side of the fixture moved inward, contacting the member and aligning it against the stationary left, or rear, side.

The hot member was straightened and completely surrounded by the fixture except for the flange edges and along a narrow central portion of the web. Heat flow from the hot member to the cold fixture effected the quench. After it was sufficiently cooled, the right die wall was retracted, the punch raised, and the frame was drawn from the fixture.

This preliminary experiment proved the feasibility of a machine to straighten and quench a side member in a single mechanized operation. Comparable to hot forming, it did not set up residual stresses in the work. If residuals had been present, distortions would have occurred when the member was released from the fixture. Although encouraged by the apparent soundness of this approach, it was considered desirable to conduct further investigation aimed at developing superior mechanical properties in low-alloy steels.

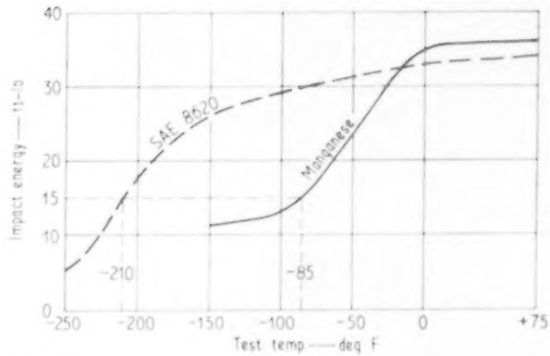
For this purpose, a shorter experimental fixture was built. It was similar in mechanical operation to the first machine, but with the notable exception that water was introduced as the quench medium. The punch and die walls were cored out to permit the passage and even distribution of water. Grid-like die surfaces permitted the controlled circulation of quench water around the member after it was straightened. Repeated experiments revealed that, as a result of abundant water circulation, the transformation temperature was lowered and a martensite structure was produced in the stock material.

Chemical Composition

Chemical Element	*Intermediate Manganese*	*SAE-8620*
Carbon	0·22-0·30	0·18-0·23
Manganese	1·00-1·35	0·70-0·90
Chromium		0·40-0·60
Nickel		0·40-0·70
Molybdenum		0·15-0·25
Silicon		0·20-0·35
Phosphorus (max)	0·04	0·04
Sulphur (max)	0·05	0·05

Mechanical Properties

	Intermediate Manganese	*SAE-8620*
Yield Strength	117,000 (ave)	113,500 (ave)
Tensile Strength	127,500 (ave)	126,600 (ave)
Elongation	17 per cent	17½ per cent



Charpy V-notch test, longitudinally oriented. Specimens $\frac{2}{3}$-standard size

Production machine

It was learned that one of the critical points in the process was the transfer of the heated workpiece from the furnace to the straightening and quenching machine. A transfer mechanism was developed which was extremely rapid in operation and, in addition, further reduced manual labour. The mechanism was designed to reach into the furnace, rapidly withdraw the work to a predetermined stop, and then approach the quench machine and push it into position in the fixture. This completed the establishment of parameters for a production machine that would ensure both the full development of hardness potential and uniformity of hardness throughout the long members.

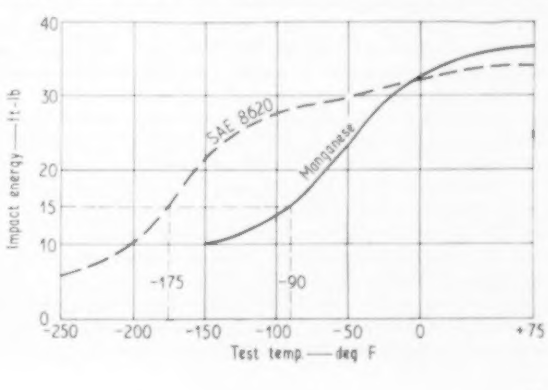
Major items of the specification of the completed machine follow:

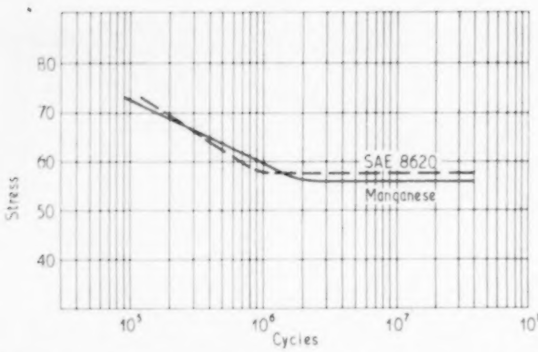
Pump capacity—2,500 gal/min, requiring 200 h.p.
Capacity of sump—30,000 gal
Die opening—8 in to 18 in
Length of workpiece—up to 40 ft
Thickness of material—$\frac{1}{4}$ in to $\frac{3}{8}$ in
Specified hardness—265 to 340 BHN

Metallurgy

Coincident with the development of this machine, a metallurgical research programme was carried out to find and evaluate an alloy steel which would fully utilize the machine's capabilities. A study of low-alloy steels indicated a cost

Charpy V-notch test, transversely oriented. Specimens $\frac{2}{3}$-standard size





Pulsating tension fatigue tests at 110,000 lb/in² minimum yield. Test specimens ¼ in plate material, with hot-rolled, heat-treated surface

advantage in favour of a particular manganese alloy. Currently used side-member alloy steels cost as much as 69 per cent more than carbon steel, while only a 16 per cent increase was associated with this intermediate manganese material. As indicated in the table of chemical compositions, it is the leaner alloy.

The intermediate manganese possessed a potential to develop properties comparable to enriched steels, provided a more potent quench was used. This is fundamentally true since the hardness of alloy steels is dependent upon carbon content while the hardenability is effected by the alloy elements. Mathematically expressed, the hardenability effect of M per cent nickel plus N per cent chromium acting on 0·25 per cent carbon steel is equivalent to the hardenability of X per cent manganese plus the potent cooling power of the quench medium acting on 0·25 per cent carbon steel. Controlled tests run by the Company's research metallurgists confirmed the validity of this relationship.

First, laboratory tests were conducted comparing the properties of richly alloyed and easily hardened SAE-8620 with the intermediate manganese material. These tests showed comparable physical properties and metallographic structures in as-quenched and tempered specimens. For example, quenching both steels from 1,650 deg F to the same hardness level—280 to 285 Brinell—produced the tabulated results. Test specimens of ¼ in gauge flat plate were used to simulate the typical product, instead of polished bars. In all cases, the micro-structure consisted of 95 per cent martensite.

For notch toughness, the Charpy impact transition curves of longitudinally oriented specimens of two-thirds standard size showed a 15 ft-lb transition temperature of −85 deg F for the manganese steel while a −210 deg F was obtained for SAE-8620. Room temperature values of 75 deg F were approximately equal. Transversely oriented specimens exhibited 15 ft-lb transition temperatures of −90 deg F for the manganese and −175 deg F for the SAE-8620. Again, room temperatures were approximately equal. From these curves it is apparent that the materials were tough at normal and sub-normal temperatures.

Pulsating tension tests, made on specimens with hot-rolled and heat-treated surfaces, indicated an endurance limit of 56,000 lb/in² for the manganese and 57,500 lb/in² for the SAE-8620; very good values considering the surface conditions of the test specimens. Fatigue resistance characteristics were illustrated by S-N curves.

Further tests in the welding-research laboratories showed that the intermediate manganese steel, in either as-rolled or heat-treated condition, can be arc welded easily without preheat. The danger of under-bead cracking is negligible. A low-hydrogen rod depositing weld metal similar to that of the parent metal should be employed, such as AWS 11018. As in all hardened-steel weld applications, a heat-affected zone is produced. All practical precautions, of course, should be taken to hold this area to a minimum.

Ceramic Fibre

A BOOKLET published by the Carborundum Company, Niagara Falls, New York, U.S.A, contains a list of the chemical, thermal and mechanical properties of a new insulating material named Fiberfrax. The booklet also reviews some of the many industrial applications of this material, which is claimed to withstand temperatures of up to 2,300 deg F. Fiberfrax, which consists of alumina-silica fibres, can be produced in a wide variety of prefabricated forms—bulk, chopped, board, paper, rope, laminates and tubes—and can also be cast or used as cement. Copies of this booklet are available from the manufacturers.

Phosphating Process

SEVERAL advantages are claimed for Kephos, a new non-aqueous phosphating process introduced by the Paints Division of Imperial Chemical Industries Ltd. This process, which produces a sealed phosphate coating, dispenses with rinsing and tank-heating, and forms no sludge in the processing tank. The coating enhances paint adhesion and resistance to rust creep in the same manner as do zinc or iron phosphate coatings produced by conventional processes.

It is stated by I.C.I. that the sealer is effective for up to a week when the coated items are stored outdoors, and for up to six months in the case of indoor storage. Under normal production conditions, welding through the Kephos film is practicable. Application of the phosphate is by dipping, spray or brush; the relatively high cost of the chemicals should be more than offset by the compactness and simplicity, and the low operating and maintenance costs, of the plant.

Dial Type Thermometer

IN THE October issue of *Automobile Engineer*, the Zero Re-Set dial type thermometer was briefly described. On this instrument, which is manufactured by British Rototherm Co. Ltd, of Merton Abbey, London, S.W.19, provision is

The Zero Re-Set thermometer, showing how the adjustment is effected

made externally for re-setting the pointer to zero in the event of its falling out of adjustment. We regret that in our previous article, this instrument was inadvertently incorrectly illustrated; the appropriate pictures are reproduced above.

CURRENT PATENTS

SELECTED ABSTRACTS OF RECENTLY ISSUED SPECIFICATIONS

Combined Springs and Dampers

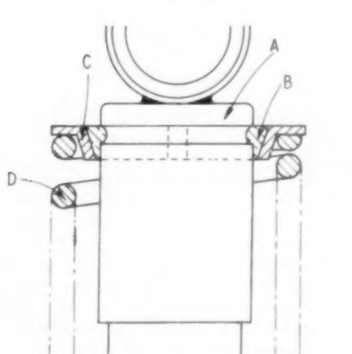
IN this patent specification is described a simple method of assembling a concentrically mounted coil spring and damper unit. Each end of spring D abuts against a flanged ring C that is not an integral part of the assembly but is attached to the damper body A in a manner such that it can be readily removed. The flange is innermost and tapered, so as to compress an intermediate tapered, split ring B against the body. Location of the ring is effected by an annular groove near the end of the body, which registers with an inner lip on ring B. *Patent No.* 873193. *Fichtel and Sachs A.G. (Germany).*

Universal joint

A UNIVERSAL joint for a vehicle drive shaft is described, the needle roller bearings of which are replaced by rubber bushes. Three advantages are claimed for this arrangement; they are: the need for lubrication is obviated, the assembly operation is a simple one, and a degree of torsional flexibility is afforded. The joint is of the Hooke's coupling type with two yoke-members A and B, and a spider C.

Into each hole in the yoke members is pressed a sleeve that is flanged at one end and has a taper bore; the flange abuts against the outer face of the yoke, and the small-diameter end of the bore is innermost. The four rubber bushes E are of frustro-conical shape, with parallel bores, and are axially located, on the shouldered journals of the spider, by washers held by set-screws axially disposed in the ends of the journals.

No. 873193

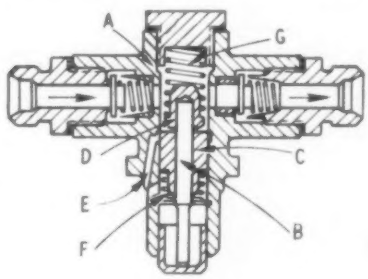


These set screws serve to pre-load the bushes, and the washers are of sufficiently large diameter to spread the rubber radially over the flanged part of sleeve D. *Patent No.* 872877. *Birfield Engineering Ltd.*

Fuel pump

THIS invention is designed to be more compact than conventional fuel pumps for internal combustion engines. The body A of the pump is basically of T-shape, with a reciprocating plunger housed in the upright portion, and non-return valves in the arms. Fuel flows from an intake duct at one end of the cross-piece, through a pumping chamber to the delivery duct at the other end.

A free piston C slides in the bore of the upright portion, and a long mechanically actuated plunger B slides in an axial hole in the piston. Inward movement of the



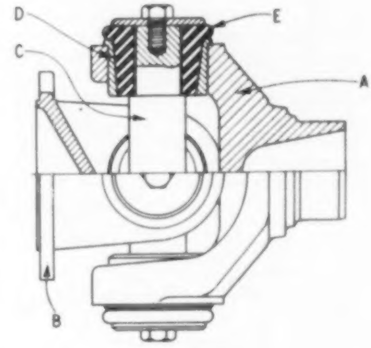
No. 867801

plunger is resisted by a compression spring G that abuts against a top hat section cap D fitted over and secured to the end of the plunger. Axial movement of the piston C is resisted in one direction by the underside of the flange of cap D, and in the other by a compression spring F that is axially located by a circlip in the bore of A.

During a delivery stroke, C stays in contact with D as long as delivery pressure is normal, but is forced away from it when this pressure is high. If the pressure is only slightly higher than normal, C is restrained from its previous reciprocating motion and no longer assists in the pumping action. With a much higher delivery pressure, however, C is forced further along the bore, and thereby uncovers a pressure-relief port E in the wall of the bore, through which the surplus fuel is returned to the tank. *Patent No.* 867801. *Daimler-Benz A.G. (Germany).*

One-way clutch

SOME conventional one-way clutch or brake devices have integrally machined ramps, which means that a surface defect on one ramp would necessitate the scrap-

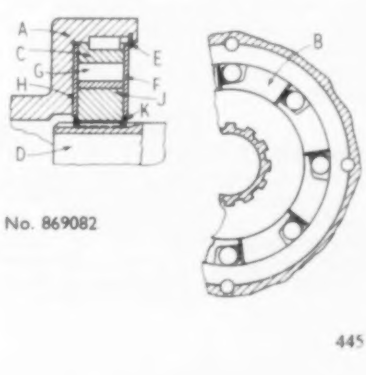


No. 872877

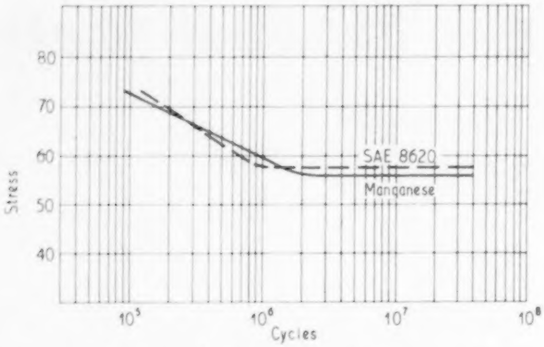
ping of the whole unit, otherwise the load distribution would be uneven. This problem is overcome in the design contained in this patent specification, and two other advantageous features are also included. These are that between rubbing faces there is a large area of contact on drive, but no contact during overrun.

Driving member A contains the outer plain race C, which is dowelled to prevent rotation. Driven member D is splined to inner race J, and axial location is effected by two circlips K. In the annulus between the two races there is a ring of small, L-shape shoes B, the foot of each L lying circumferentially and being of wedge shape, with its thin end closest to the adjacent shoe. The height of the stem of each L is such as to allow a working radial clearance in the annulus.

A roller G rests in the angle of each shoe, with its axis parallel to that of the races, and by the action of a small spring M, between it and the next shoe, is constrained to stay high on the ramp, and in contact with the outer race. Two flat rings F and H locate the assembly axially in A, and they are retained by a circlip E. When driving member A is rotating so quickly that the shoes are forced against the outer race by centrifugal force, there is, of course, no contact between shoes and inner race. *Patent No.* 869082. *General Motors Co. (U.S.A.).*



No. 869082



Pulsating tension fatigue tests at 110,000 lb/in² minimum yield. Test specimens ¼ in plate material, with hot-rolled, heat-treated surface

advantage in favour of a particular manganese alloy. Currently used side-member alloy steels cost as much as 69 per cent more than carbon steel, while only a 16 per cent increase was associated with this intermediate manganese material. As indicated in the table of chemical compositions, it is the leaner alloy.

The intermediate manganese possessed a potential to develop properties comparable to enriched steels, provided a more potent quench was used. This is fundamentally true since the hardness of alloy steels is dependent upon carbon content while the hardenability is effected by the alloy elements. Mathematically expressed, the hardenability effect of M per cent nickel plus N per cent chromium acting on 0·25 per cent carbon steel is equivalent to the hardenability of X per cent manganese plus the potent cooling power of the quench medium acting on 0·25 per cent carbon steel. Controlled tests run by the Company's research metallurgists confirmed the validity of this relationship.

First, laboratory tests were conducted comparing the properties of richly alloyed and easily hardened SAE-8620 with the intermediate manganese material. These tests showed comparable physical properties and metallographic structures in as-quenched and tempered specimens. For example, quenching both steels from 1,650 deg F to the same hardness level—280 to 285 Brinell—produced the tabulated results. Test specimens of ¼ in gauge flat plate were used to simulate the typical product, instead of polished bars. In all cases, the micro-structure consisted of 95 per cent martensite.

For notch toughness, the Charpy impact transition curves of longitudinally oriented specimens of two-thirds standard size showed a 15 ft-lb transition temperature of −85 deg F for the manganese steel while a −210 deg F was obtained for SAE-8620. Room temperature values of 75 deg F were approximately equal. Transversely oriented specimens exhibited 15 ft-lb transition temperatures of −90 deg F for the manganese and −175 deg F for the SAE-8620. Again, room temperatures were approximately equal. From these curves it is apparent that the materials were tough at normal and sub-normal temperatures.

Pulsating tension tests, made on specimens with hot-rolled and heat-treated surfaces, indicated an endurance limit of 56,000 lb/in² for the manganese and 57,500 lb/in² for the SAE-8620; very good values considering the surface conditions of the test specimens. Fatigue resistance characteristics were illustrated by S-N curves.

Further tests in the welding-research laboratories showed that the intermediate manganese steel, in either as-rolled or heat-treated condition, can be arc welded easily without preheat. The danger of under-bead cracking is negligible. A low-hydrogen rod depositing weld metal similar to that of the parent metal should be employed, such as AWS 11018. As in all hardened-steel weld applications, a heat-affected zone is produced. All practical precautions, of course, should be taken to hold this area to a minimum.

Ceramic Fibre

A BOOKLET published by the Carborundum Company, Niagara Falls, New York, U.S.A, contains a list of the chemical, thermal and mechanical properties of a new insulating material named Fiberfrax. The booklet also reviews some of the many industrial applications of this material, which is claimed to withstand temperatures of up to 2,300 deg F. Fiberfrax, which consists of alumina-silica fibres, can be produced in a wide variety of prefabricated forms—bulk, chopped, board, paper, rope, laminates and tubes—and can also be cast or used as cement. Copies of this booklet are available from the manufacturers.

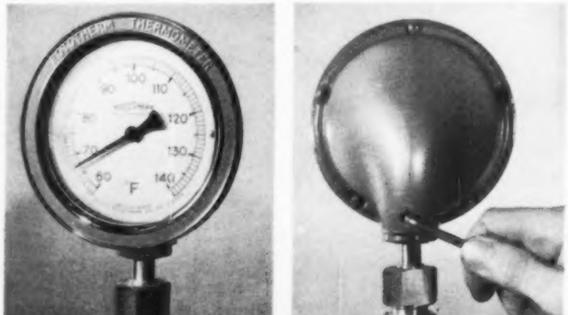
Phosphating Process

SEVERAL advantages are claimed for Kephos, a new non-aqueous phosphating process introduced by the Paints Division of Imperial Chemical Industries Ltd. This process, which produces a sealed phosphate coating, dispenses with rinsing and tank-heating, and forms no sludge in the processing tank. The coating enhances paint adhesion and resistance to rust creep in the same manner as do zinc or iron phosphate coatings produced by conventional processes.

It is stated by I.C.I. that the sealer is effective for up to a week when the coated items are stored outdoors, and for up to six months in the case of indoor storage. Under normal production conditions, welding through the Kephos film is practicable. Application of the phosphate is by dipping, spray or brush; the relatively high cost of the chemicals should be more than offset by the compactness and simplicity, and the low operating and maintenance costs, of the plant.

Dial Type Thermometer

IN THE October issue of *Automobile Engineer*, the Zero Re-Set dial type thermometer was briefly described. On this instrument, which is manufactured by British Rototherm Co. Ltd, of Merton Abbey, London, S.W.19, provision is



The Zero Re-Set thermometer, showing how the adjustment is effected

made externally for re-setting the pointer to zero in the event of its falling out of adjustment. We regret that in our previous article, this instrument was inadvertently incorrectly illustrated; the appropriate pictures are reproduced above.

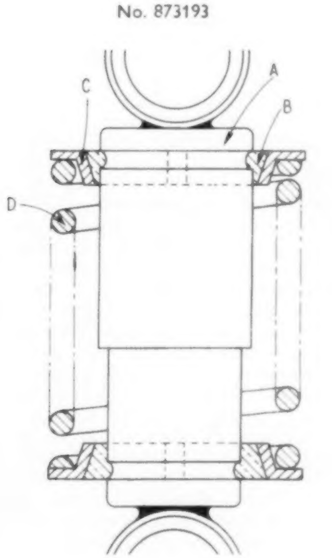
CURRENT PATENTS

SELECTED ABSTRACTS OF RECENTLY ISSUED SPECIFICATIONS

Combined Springs and Dampers

IN this patent specification is described a simple method of assembling a concentrically mounted coil spring and damper unit. Each end of spring D abuts against a flanged ring C that is not an integral part of the assembly but is attached to the damper body A in a manner such that it can be readily removed. The flange is innermost and tapered, so as to compress an intermediate tapered, split ring B against the body. Location of the ring is effected by an annular groove near the end of the body, which registers with an inner lip on ring B. *Patent No.* 873193. *Fichtel and Sachs A.G.* (*Germany*).

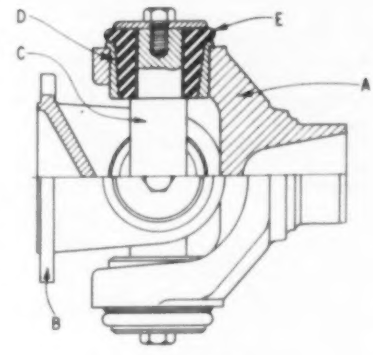
No. 873193



Universal joint

A UNIVERSAL joint for a vehicle drive shaft is described, the needle roller bearings of which are replaced by rubber bushes. Three advantages are claimed for this arrangement; they are: the need for lubrication is obviated, the assembly operation is a simple one, and a degree of torsional flexibility is afforded. The joint is of the Hooke's coupling type with two yoke-members A and B, and a spider C.

Into each hole in the yoke members is pressed a sleeve that is flanged at one end and has a taper bore; the flange abuts against the outer face of the yoke, and the small-diameter end of the bore is innermost. The four rubber bushes E are of frustro-conical shape, with parallel bores, and are axially located, on the shouldered journals of the spider, by washers held by set-screws axially disposed in the ends of the journals. These set screws serve to pre-load the bushes, and the washers are of sufficiently large diameter to spread the rubber radially over the flanged part of sleeve D. *Patent No.* 872877. *Birfield Engineering Ltd.*

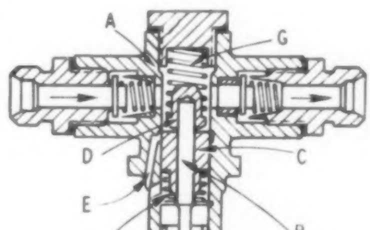


No. 872877

Fuel pump

THIS invention is designed to be more compact than conventional fuel pumps for internal combustion engines. The body A of the pump is basically of T-shape, with a reciprocating plunger housed in the upright portion, and non-return valves in the arms. Fuel flows from an intake duct at one end of the cross-piece, through a pumping chamber to the delivery duct at the other end.

A free piston C slides in the bore of the upright portion, and a long mechanically actuated plunger B slides in an axial hole in the piston. Inward movement of the plunger is resisted by a compression spring G that abuts against a top hat section cap D fitted over and secured to the end of the plunger. Axial movement of the piston C is resisted in one direction by the underside of the flange of cap D, and in the other by a compression spring F that is axially located by a circlip in the bore of A.



No. 867801

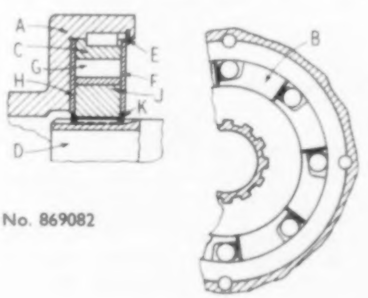
During a delivery stroke, C stays in contact with D as long as delivery pressure is normal, but is forced away from it when this pressure is high. If the pressure is only slightly higher than normal, C is restrained from its previous reciprocating motion and no longer assists in the pumping action. With a much higher delivery pressure, however, C is forced further along the bore, and thereby uncovers a pressure-relief port E in the wall of the bore, through which the surplus fuel is returned to the tank. *Patent No.* 867801. *Daimler-Benz A.G.* (*Germany*).

One-way clutch

SOME conventional one-way clutch or brake devices have integrally machined ramps, which means that a surface defect on one ramp would necessitate the scrapping of the whole unit, otherwise the load distribution would be uneven. This problem is overcome in the design contained in this patent specification, and two other advantageous features are also included. These are that between rubbing faces there is a large area of contact on drive, but no contact during overrun.

Driving member A contains the outer plain race C, which is dowelled to prevent rotation. Driven member D is splined to inner race J, and axial location is effected by two circlips K. In the annulus between the two races there is a ring of small, L-shape shoes B, the foot of each L lying circumferentially and being of wedge shape, with its thin end closest to the adjacent shoe. The height of the stem of each L is such as to allow a working radial clearance in the annulus.

A roller G rests in the angle of each shoe, with its axis parallel to that of the races, and by the action of a small spring M, between it and the next shoe, is constrained to stay high on the ramp, and in contact with the outer race. Two flat rings F and H locate the assembly axially in A, and they are retained by a circlip E. When driving member A is rotating so quickly that the shoes are forced against the outer race by centrifugal force, there is, of course, no contact between shoes and inner race. *Patent No.* 869082. *General Motors Co.* (*U.S.A.*).

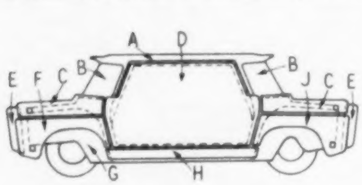


No. 869082

Car body

WITH the primary objects of reducing the number of manufacturing operations and the size of the spare parts stores, this vehicle is designed to be symmetrical about both longitudinal and transverse axes. Diagonally opposite wing pressings F and J are identical, as are bonnet and boot covers C, front and rear lights B, doors D, end pressings E and side pressings H. Roof A, and pressings E, F, H and J can be either built into a unitary structure with frame G, or assembled separately and removably. In this design the doors are, for preference, arranged to slide.

Among the advantages put forward for this type of design are: simplification of automation systems in production, reduc-



No. 867433

tion of factory floor space compared with that required for the manufacture of conventional vehicles, and lower capital outlay in tooling-up for production. Several other patents published recently have dealt with other aspects of this type of car, among them being a roof designed for carrying loads, and doors arranged to open outwards and move back on swinging arms. *Patent No.* 867433. *Daimler-Benz A.G. (Germany).*

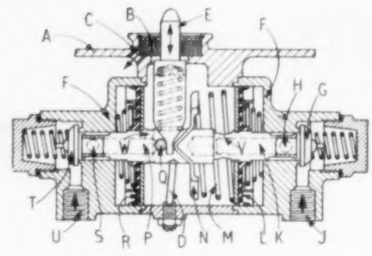
Valve Springs

WHERE helical springs are used in appliances that embody flat seatings, each has to be ground flat at the ends, and also probably deburred. In this patent specification, the spring is made of wire of circular or other section, and part of each end coil, through a sweep of approximately 260 deg, is wound in the normal manner in a plane at right angles to the spring axis. In passing to the second coil, it is necessary to incorporate a sharp bend in the first one, so that it does not foul the square-cropped end of the wire.

An interesting feature of this specification is that the helix angle of the main coils is not constant. Instead, the first half of each coil has a helix angle less than that of the second half. By this means, it is claimed, the spring can be compressed to a minimum solid length without high local stresses. *Patent No.* 870368. *Ford Motor Co.*

Front wheel suspension

THIS suspension unit is, in essence, a vertical telescopic device that contains both oil as a damping medium and gas as a springing medium. The top of the upper component E is flexibly attached to the vehicle chassis, and beneath the lower



No. 868081

component F there is a ball joint G by which it is connected to a wishbone C. A stub axle A is embodied in the component F, which can be rotated about its sliding axis for the purpose of steering the vehicle.

Contained within F is a floating piston H, constrained to slide vertically, beneath which is the gaseous springing medium, and above which is the damping oil. F slides inside E, and when sliding motion occurs, the oil flows through holes in an end-plate J at the top of F. These holes can contain valves to determine the damping characteristics.

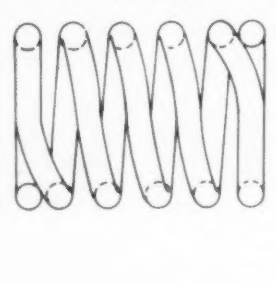
Extending upwards from the flat top of E there is a small-diameter threaded rod R. which passes through a hole in the chassis member B. By the fitting of two rubber washers M and N, and a nut P, to the rod, a sandwich mount is formed which attaches the telescopic unit flexibly to the chassis. E can be fitted with a union Q at this upper end, through which oil can be inserted either for topping-up or for varying the height of the vehicle.

Steering movements can be transmitted to F by any convenient means, but a suggested method is illustrated. The end-plate J has a splined central hole that is a sliding fit with a splined portion of a vertical shaft K, whose plain portion passes through the hollow rod R. At the upper end of the shaft is a steering arm L; rotation of this arm is thus transmitted to F. *Patent No.* 869296. *Standard Motor Co. Ltd.*

Brake valve assembly

THIS patent deals with a control valve for two-line air braking systems of heavy vehicles. The advantages claimed, relative to conventional valve assemblies, are compactness, ease of maintenance and interchangeability of components. As can be seen from the illustration, the main component, which is attached to the toe-board of the vehicle, is a central casting A. Spigoted into the open ends of this casting

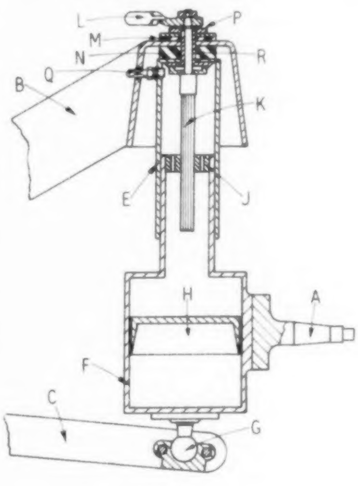
No. 870368



are two valve bodies F, each of which is connected to a separate brake line.

Compressed air enters the port U in the left-hand body and, when member P is slid axially to lift the valve-plate T from its seating, is delivered to one brake line through orifice S. Similarly, when member K lifts the valve G, air for the other line enters at J and is delivered through H. When the brakes are not in use, their slave cylinders are in communication with atmosphere through the axially drilled holes in P and K, the radial holes W and V, the filter B and the outlet hole C.

The plunger E that moves the members P and K is coupled to the brake pedal, not shown, and its actuating surfaces bear against a pin Q, projecting each side of P, and a ridged spring-plate N sliding on P. Plunger E is, of course, bifurcated, and straddles P; its flanks act as a surface cam of progressively steeper slope. Drilled in the end of P is a socket, into which the end of K projects. When the plunger E is

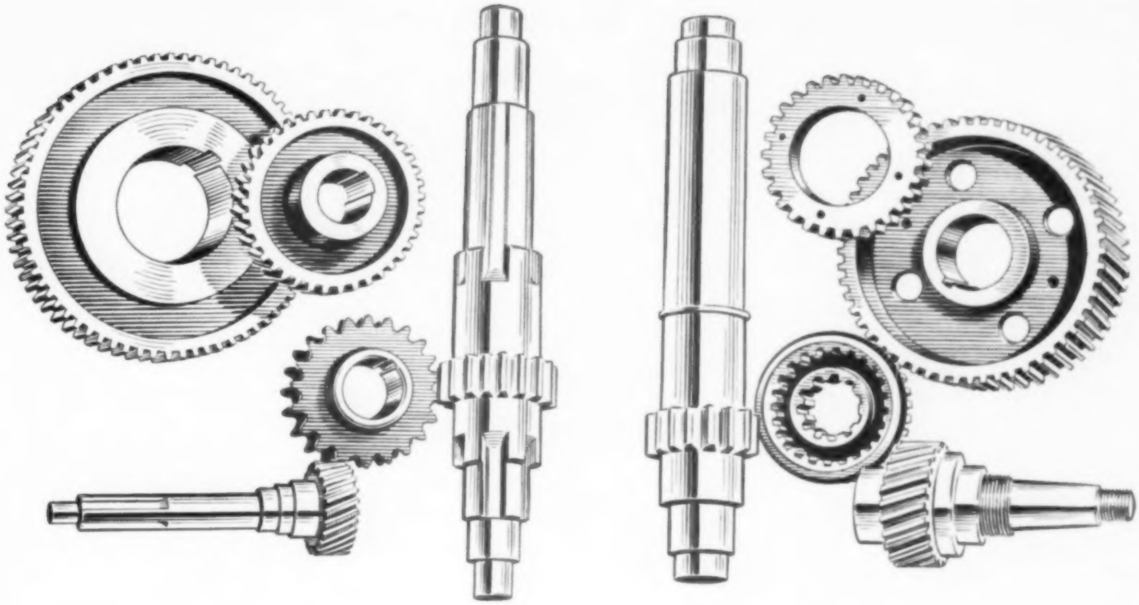


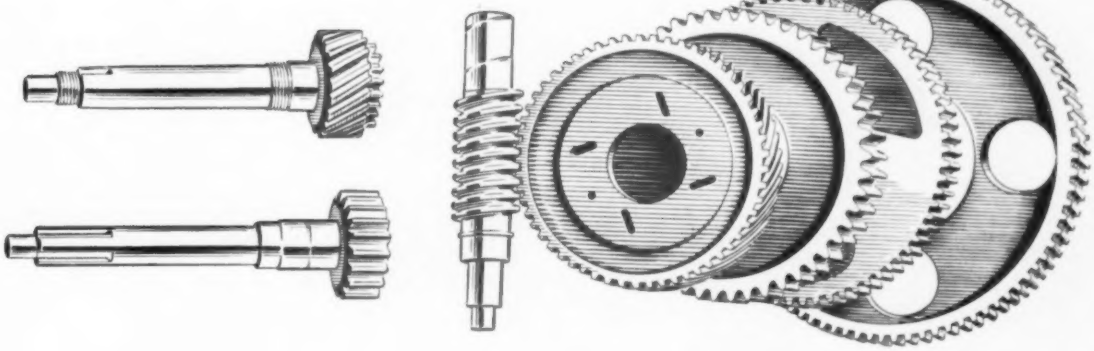
No. 869296

depressed, members P and K move in opposite directions, one being moved directly by pin Q, and the other indirectly through spring M acting against piston L.

The ends of P and K are valve seats which, when they contact the valve-plates T and G, cut off the connection between atmosphere and slave cylinders. As soon as the plates lift, air passes through the clearance spaces between P and K and the bores in which they slide, and enters the chambers behind pistons R and L. Thus, a slight reaction is transmitted to the driver through the plunger E; the magnitude of the reaction varies according to the position of the plunger and the steepness of the part of its flank that is acting on the pin Q and the spring plate N.

Beneath P is a short reaction strut D, to resist the downward force applied by the plunger. Removal of the body F, and replacements of plunger E or spring M, are simple to effect. An additional advantage claimed is that there is little likelihood of confusion of the connections during repairing operations. *Patent No.* 868081. *Robert Bosch G.m.b.H. (Germany).*





On the Motorway

A completely new conception of public transport has been made possible by the London-Birmingham Motorway, with coaches cruising at speeds of 70-80 m.p.h. over its full length. These Midland Red Motorway Express Coaches, typifying this new era, are fitted with every modern device for safe, economical operation.

Glacier Centrifugal Oil Filters, for Transport and Commercial Vehicle Engines ensure optimum oil cleanliness at minimum operational cost.

THE GLACIER *centrifugal* OIL FILTER

Fitted, among others, by the following leading engine manufacturers :-

LEYLAND MOTORS. DAIMLER - BENZ. ALBION MOTORS. CROSSLEY BROS. FIAT. BIRMINGHAM & MIDLAND MOTOR OMNIBUS CO. ISOTTA-FRASCHINI. E.N.A.S.A. (PEGASO) SPAIN. DAIMLER. SCANIA-VABIS.

Compared with conventional filters, Glacier extractors have a number of advantages :-

- They remove—consistently—particles down to under a micron.
- They have up to 10 times the dirt capacity of conventional filters, do not choke, and oil does not pass through contaminated sludge during filtration.
- They hold the percentage of contaminant of oil down to a level as low as 0.2% by weight.
- They enable the period between oil changes to be lengthened by up to 4 times.
- There is no element to be replaced at each cleaning.

GLACIER

FREE!
Send for Designer's Handbook No. 3 on Filters.
All correspondence on Filters to be addressed to:-
The Glacier Metal Co. Ltd., Kilmarnock, Ayrshire, Scotland.

THE GLACIER METAL COMPANY LTD · Alperton · Wembley · Middlesex.

Car parts take a beating in today's traffic

Modern cars need modern materials—materials like Tufnol, made in numerous brands with predetermined properties, each formulated to satisfy particular requirements.

Tufnol—a laminated plastics material—has a wide range of properties which makes it eminently suitable for automobile components. Light yet strong and hardwearing, it is not damaged by petrol, oil, dilute acids or climatic conditions; it is an electrical and thermal insulator, is dimensionally stable and machines easily using ordinary tools. Available in sheets, tubes, rods, bars, angles, channels and mouldings, it can be stored indefinitely, and resists attack from insects, rodents and fungi.

The Tufnol Zodiac is your guide to the twelve most important brands of this remarkable material. Get to know them and ensure yourself a more trouble-free future. Full information and our technical service are always available.


VOLE BRAND

TUFNOL
(Regd. Trade Mark)

TUFNOL LIMITED · PERRY BARR · BIRMINGHAM 22B

437

ADVERTISEMENT

A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.
The tremendous power and complexity of rocket-propelled vehicles set still more-exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	*PEAK THRUST*
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

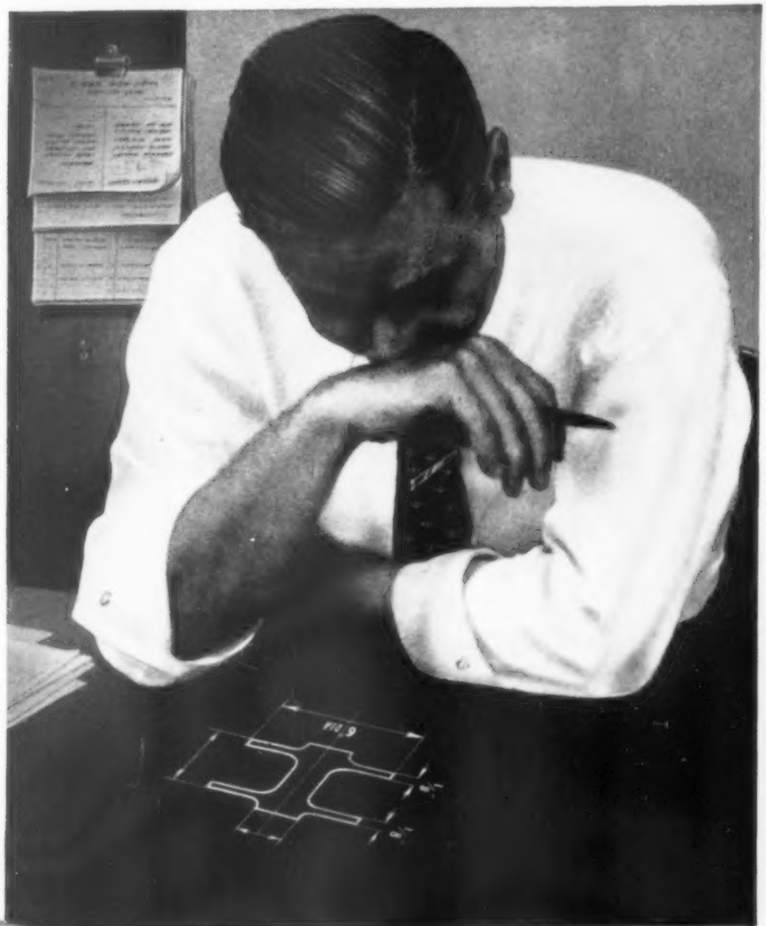
GOODMANS
the vibration specialists

GOODMANS INDUSTRIES LTD. AXIOM WORKS, WEMBLEY, MIDDLESEX ENGLAND Wembley 1200 (8 lines) Cables : Goodaxiom, Wembley, England

Accredited Agents : HAWNT & CO. BIRMINGHAM · FARNELL INSTRUMENTS LTD. WETHERBY YORKS · A. R. BOLTON & CO. LTD. EDINBURGH

GD659

The designer knew a FORGING was the only answer



★ *Diametrically opposed sectioning to illustrate uniformity of grain flow.*

—but could he get it?

The problem here was that any machining likely to interfere with the generation of grain flow through the central barrel to the periphery had to be eliminated. It looked impossible, everything appeared to be against its manufacture, including forging, but as always the seemingly impossible was achieved by Light-Metal Forgings Ltd.

For STEEL Drop Forgings :

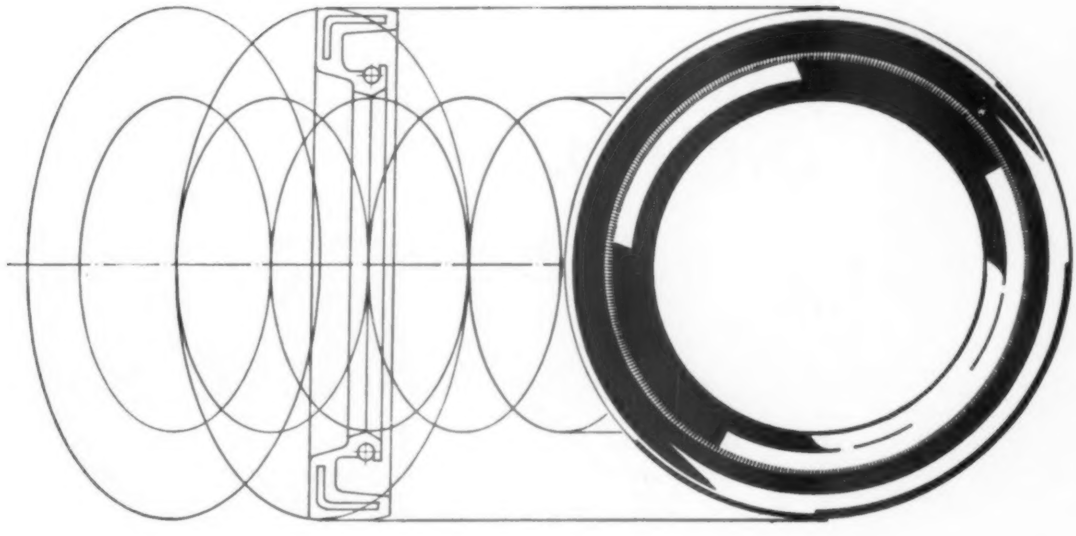
THE HUGHES-JOHNSON STAMPINGS LTD.

LANGLEY GREEN,
BIRMINGHAM.

For NON-FERROUS Drop Forgings :

LIGHT-METAL FORGINGS LTD.

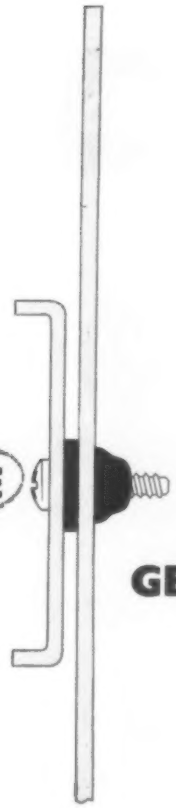
OLDBURY,
BIRMINGHAM.



FIXED FIRMLY

BOTH SIDES

FROM HERE -WITHOUT



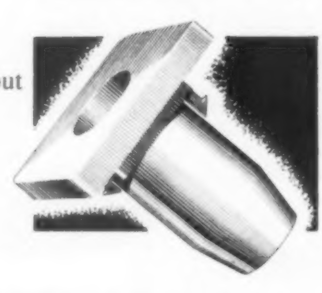
GETTING ROUND

HERE...

GKN *solve one-sided assembly problems with these New Low-Cost High-Speed Fasteners—*

* No tapping
* Assembly from one side
* Insulated fixing
* High strength/weight ratio
* No special tools required
* Vibration-proof
* Clips in position and cannot fall out
* Dust and moisture proof
* Low cost

NPK Self-Tapping Screw



INSULGRIP Shock and vibration-proof Fastener in Nylon

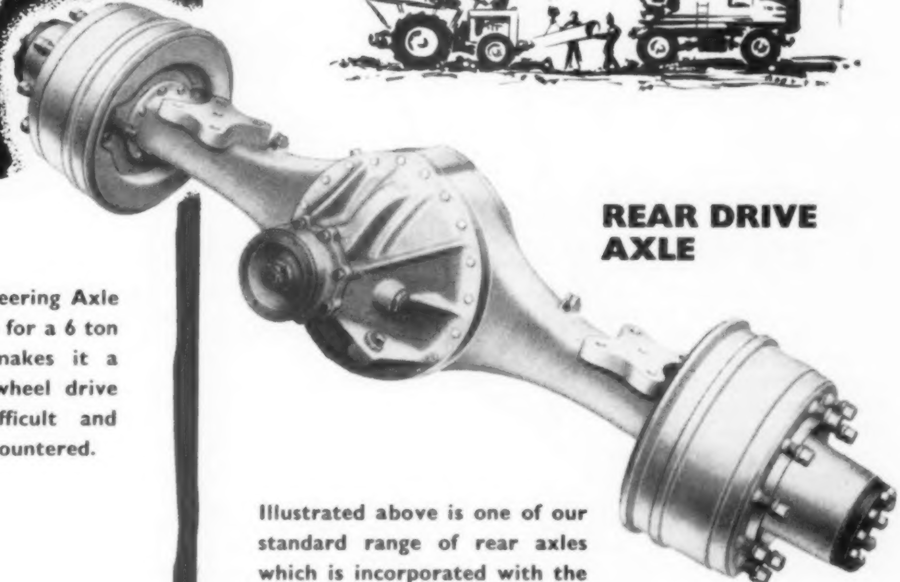
Write today for fully descriptive literature

GEORGE GOODMAN LTD

ROBIN HOOD LANE · BIRMINGHAM 28 · TELEPHONE: SHIRLEY 4491

MADE by MOSS

FRONT DRIVE STEERING AXLE



REAR DRIVE AXLE

The Front Drive Steering Axle assembly is suitable for a 6 ton tyre load which makes it a perfect unit for 4-wheel drive systems where difficult and boggy terrain is encountered.

Illustrated above is one of our standard range of rear axles which is incorporated with the 4-wheel drive transmission.

MOSS GEAR CO. LTD

CROWN WORKS · TYBURN · BIRMINGHAM 24
Telephone Erdington 1661-6 Telegrams "Mosgear Birmingham"

other fleets gain you 5 year saving..

Scores of operators who first made one-vehicle tests, covering several years, now fit AL-FIN armoured pistons throughout their fleets. Some shrewdly specify AL-FIN as *original* equipment when ordering new vehicles.

Those test years have returned them big dividends in double mileage, reduced breakdowns, and lower maintenance costs. You gain years of extra benefit from that experience by standardising on AL-FIN *now*, fitting each vehicle as it comes in for overhaul.

Write for full details today to Dept. ALC

AL-FIN bi-metallic armoured pistons

Unique AL-FIN Pistons embody an iron belt molecularly bonded to the aluminium body, providing an armoured top ring groove of twice the normal wear-resistance.

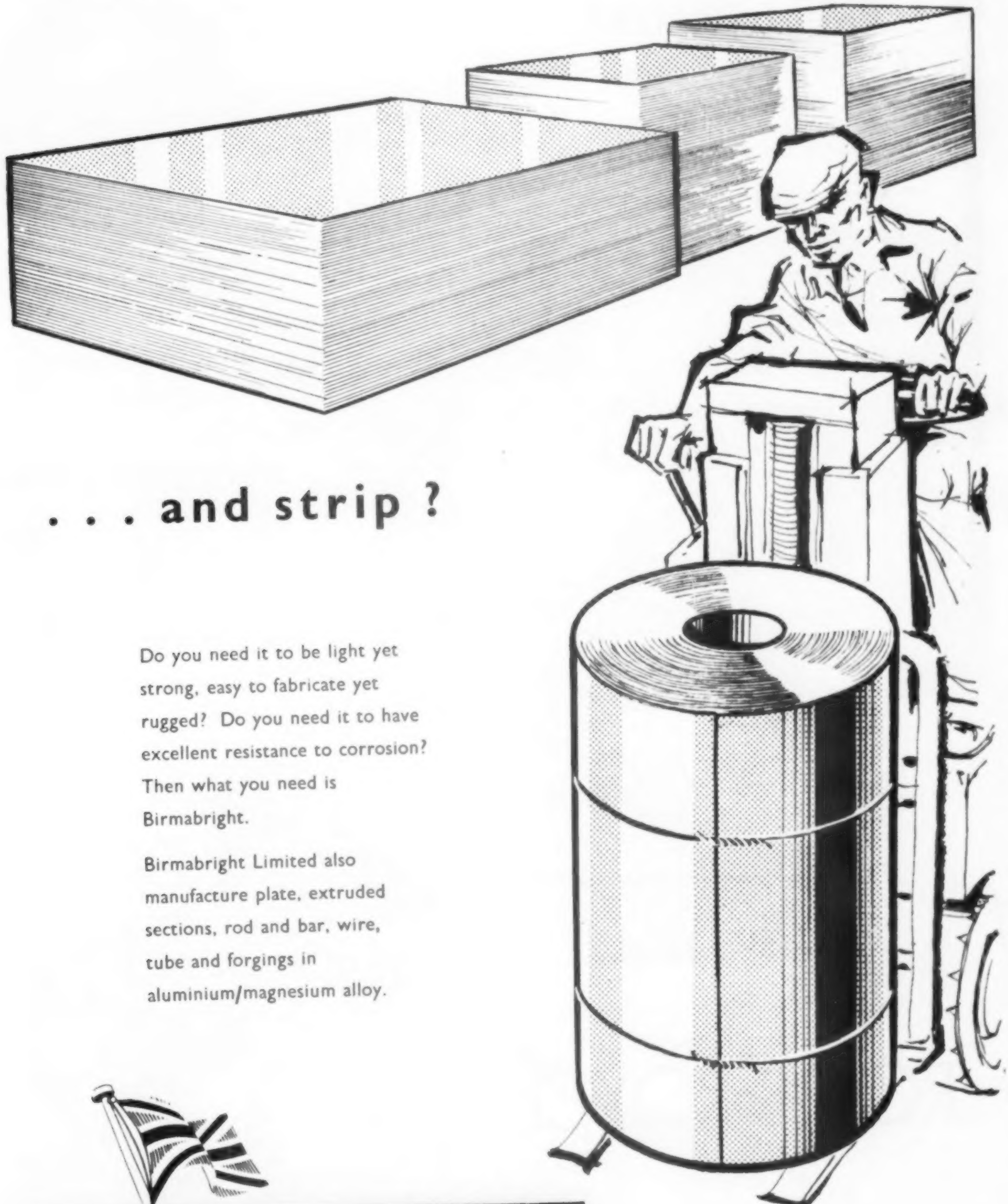
WELLWORTHY

WELLWORTHY LIMITED • LYMINGTON • HAMPSHIRE

AN ASSOCIATED ENGINEERING (SALES) LTD. COMPANY


the facts about
Harper SG iron
...send now for this leaflet

Do you use sheet . . .



. . . and strip ?

Do you need it to be light yet strong, easy to fabricate yet rugged? Do you need it to have excellent resistance to corrosion? Then what you need is Birmabright.

Birmabright Limited also manufacture plate, extruded sections, rod and bar, wire, tube and forgings in aluminium/magnesium alloy.

Birmabright

Registered Trade Mark

Birmabright Limited

WOODGATE WORKS · BIRMINGHAM 32

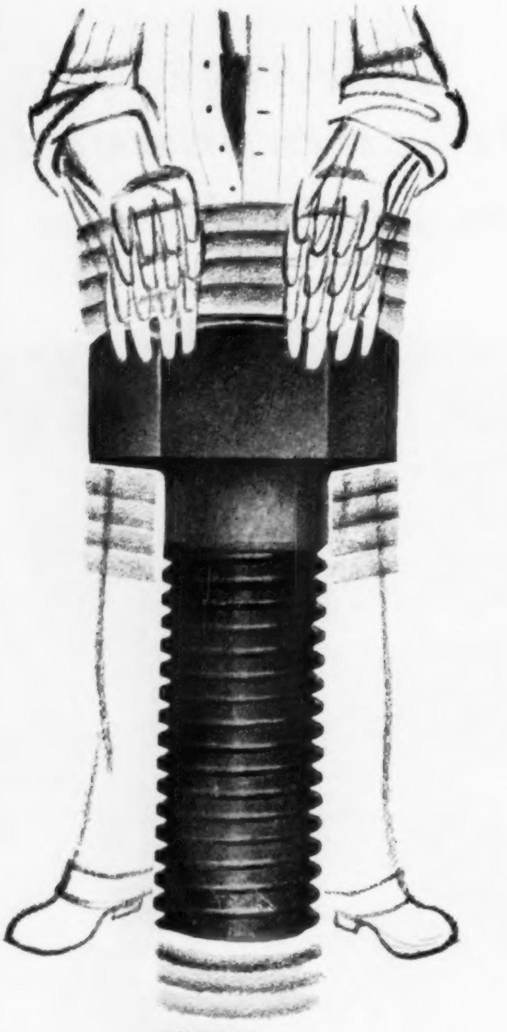
BM 287

Concentric components
create confidence

We are the specialists

Concentric (Engineering) Ltd. Tyburn Road, Birmingham 24

TELEPHONE : EAST 2081/2/3/4/5/6



now do you see?

Pneumatic tools are an obvious application for Lanarkshire High Tensile bolts. But there are many more subtle situations where this bolt's extra strength is employed to advantage. Machine tools, bridges, motor cars, cranes.... wherever stresses and strains are to be withstood—Lanarkshire H.T. bolts and setscrews withstand. If your product needs extra strength at vital points—why not contact Lanarkshire? From 45—75 tons in R, T and V grades, Lanarkshire offer good delivery in B.S.1083 (Whitworth and B.S.F.) and B.S.1768 (fine and coarse) threads.

BOLT BUYERS acclaim the MONTHLY STOCK LIST, giving thread, size, material and quantity of bolts in stock. Ask to be mailed a copy—free.

LANARKSHIRE
BOLT LIMITED

HAMILTON, LANARKSHIRE, SCOTLAND
Tel: Hamilton 1241-5

17/3/61

to be sure !

GRIFFITHS, GILBART, LLOYD & CO. LTD.
EMPIRE WORKS, PARK ROAD, BIRMINGHAM.

"Aro-Broomwade" Model 7386C O-series High Speed Drill in operation.

"ARO-BROOMWADE" TOOLS

with noise-reducing exhaust system

Power, speed, precision and silent operation. These are the four outstanding qualities that account for the success of "Aro-Broomwade" tools. An exclusive feature of this range is an external bronze diffuser that breaks up the force of the exhaust air through thousands of tiny passages. This gentle dispersion of the exhaust air reduces operating noise to a minimum.

The "Aro-Broomwade" range includes Reversible Screwdrivers and Nutrunners, High Torque Drills and Push-pull Tappers.

"BROOMWADE"

AIR COMPRESSORS & PNEUMATIC TOOLS - YOUR BEST INVESTMENT

Broom and Wade Ltd., P.O. Box No. 7, High Wycombe, Bucks. Telephone: High Wycombe 1630 (10 lines) Telex: 83-127

892 SAS

Classified Advertisements

RATE 4d. PER WORD · MINIMUM 4/-

Each paragraph charged separately. Box numbers 5 words plus 1/-

Advertisements for November Annual Review 1961 should be sent to "Automobile Engineer," Dorset House, Stamford Street, London, S.E.1. to arrive not later than first post 9th November.

(No responsibility accepted for errors)

PATENTS

PATENT No. 713228—"New or Improved Switch Arrangement for Actuating Signalling Devices on Motor vehicles." The Proprietors of Patent No. 713228 desire to enter into arrangements by way of licence or otherwise on reasonable terms to ensure its full development and commercial working in this country.

ADDRESS enquiries to: W. P. Thompson & Company, Chartered Patent and Trade Mark Agents, 12 Church Street, Liverpool.

SITUATIONS VACANT

MECHANICAL Inspector (Foreman Grade) required.

APPLICANT should be about 40 years of age, have completed an apprenticeship with a motor vehicle manufacturer or large commercial undertaking. O.N.C. (or equivalent) an advantage. Experience must include complete overhaul of heavy commercial vehicles, compressors, pumps and electrical generating equipment. Must be able to deal with manufacturers, read drawings and be able to carry out detailed inspections. Ability to write a concise technical report and carry out administrative duties essential. Our Firm is in North-West Kent. Apply Box 4402, c/o Automobile Engineer.

TUITION

A.M.I.M.I., City & Guilds, A.M.I.Mech.E., etc., on "No-Pass-No-Fee" terms. Over 95% successes. For details of Exams and Courses in all branches of Auto, Diesel, Aero, Mechanical Eng., etc., write for 148-page Handbook—Free. B.I.E.T. (Dept. 643), 29 Wright's Lane, London, W.8. [5681

BOOKS

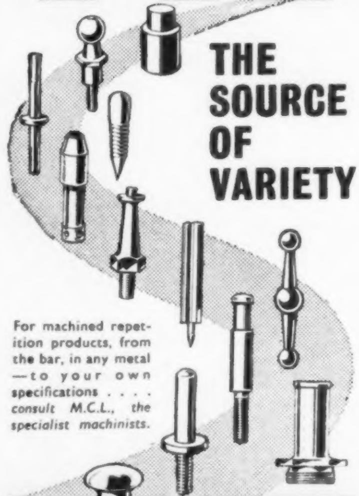
GAS Welding and Cutting: A Practical Guide to the Best Techniques. By C. G. Bainbridge, M.I.Mech.E., M.Inst.W. A comprehensive textbook providing practical information on almost the whole range of available gas welding and cutting equipment, methods and processes. Invaluable to the practical welder as well as to those responsible for gas welding and cutting operations involved in the fabrication and repair of industrial equipment. 15s. net from all booksellers. By post 16s. from Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

ABACS or Nomograms. By A. Giet. Translated from the French by H. D. Phippen and J. W. Head. Most engineers have made use of nomograms at some time in their careers, and are fully alive to the fact that they are a very convenient tool when the same formula has to be solved repeatedly for several sets of variables. It is fair to say, however, that only a small proportion of even those who habitually employ nomograms know how to construct them for their own use. Most of the comparatively small literature on the subject is written for mathematicians and is extremely difficult for the practical engineer to comprehend. This book is essentially practical, and not only demonstrates the many and varied applications of the abac or nomogram, but shows how even those without highly specialized mathematical knowledge may construct their own charts. 35s. net from all booksellers. By post 36s. from Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

RESISTANCE Welding in Mass Production. By A. J. Hipperson, B.Sc.(Eng.), A.M.Inst.W., and T. Watson, M.Inst.W. The ground covered by this book ranges from the first principles of each process to its scientific application in mass production. Particular reference is made to design and production requirements. 21s. net from all booksellers. By post 22s. 1d. from Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

MCL

THE SOURCE OF VARIETY



For machined repetition products, from the bar, in any metal—to your own specifications . . . . consult M.C.L., the specialist machinists.

PRECISION PARTS FROM THE BAR

I.F.V., D.A.I., D.I.Arm., A.R.B Fully Approved.

M.C.L. & REPETITION LTD.

POOL LANE - LANGLEY - BIRMINGHAM

Telephone: Broadwell 1115 (4 lines) and 1757

MANCHESTER CORPORATION TRANSPORT DEPARTMENT

require

PROCESS AND PLANNING OFFICER

To take charge of incentive schemes and rate fixing at the Central Repair Works and Seven Bus Garages.

SALARY £1,310/1,480 per annum.

Details and application forms from the General Manager,

55, PICCADILLY, MANCHESTER, 1;

Returnable by MONDAY, 20th NOVEMBER, 1961.

COTTON BAGS

FOR SPARE PARTS, Etc.

Walter H. Feltham & Son Ltd

Imperial Works, Tower Bridge Road
Telephone: HOP 1784 LONDON, S.E.1

CONVEYANCER FORK TRUCKS LIMITED

ASSISTANT CHIEF DESIGNER

A qualified engineer with Engineering Degree, corporate membership of Engineering Institute or equivalent qualification, is required with experience in the design of mobile mechanical handling equipment or vehicles (preferably industrial trucks) as Assistant Chief Designer.

EQUIPMENT ENGINEER

An engineer is required to be responsible for and to co-ordinate the design of fork lift trucks masts, special attachments and hydraulics. Good engineering background with drawing office experience and a H.N.C. or equivalent.

These are monthly staff appointments with pension scheme and three weeks' annual holiday. Moving expenses will be paid.

Apply with full details of career to—
Personnel Manager,

CONVEYANCER FORK TRUCKS LIMITED

LIVERPOOL ROAD, WARRINGTON

FORK-LIFT TRUCKS FOR HIRE

W. C. YOUNGMAN LIMITED,
WANDSWORTH WORKS,
WANDSWORTH ROAD, S.W.8.
Telephone MACaulay 2233.

INDEX TO ADVERTISEMENTS

Printed in Great Britain for the Publishers, ILIFFE PRODUCTION PUBLICATIONS LTD., Dorset House, Stamford St., London, S.E.1, by James Cond Ltd., Charlotte St., Birmingham 3. "Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd. Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd. Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.


Apprentices
Draughtsmen
Designers
Production Engineers
Purchasing Officers


KNOW YOUR BEARINGS

No. 9
The Single Row Self-Aligning Roller Journal

This roller bearing is the counterpart of the self-aligning ball journal bearing described in No. 6 of this series. It has slightly less load capacity than the standard roller journal of equivalent size, but has greater load capacity than the ball journal bearing of the same dimensions. The self-aligning feature, independent of the rolling elements, is provided by the outer race being ground to spherical form and fitted within a shell housing of corresponding form.

The end cover also sphered, moves with the bearing, enclosing it and maintaining a fine running clearance about the rotating parts.

They are supplied with taper clamping sleeve and nut or with parallel bore for fitting direct to the shaft.

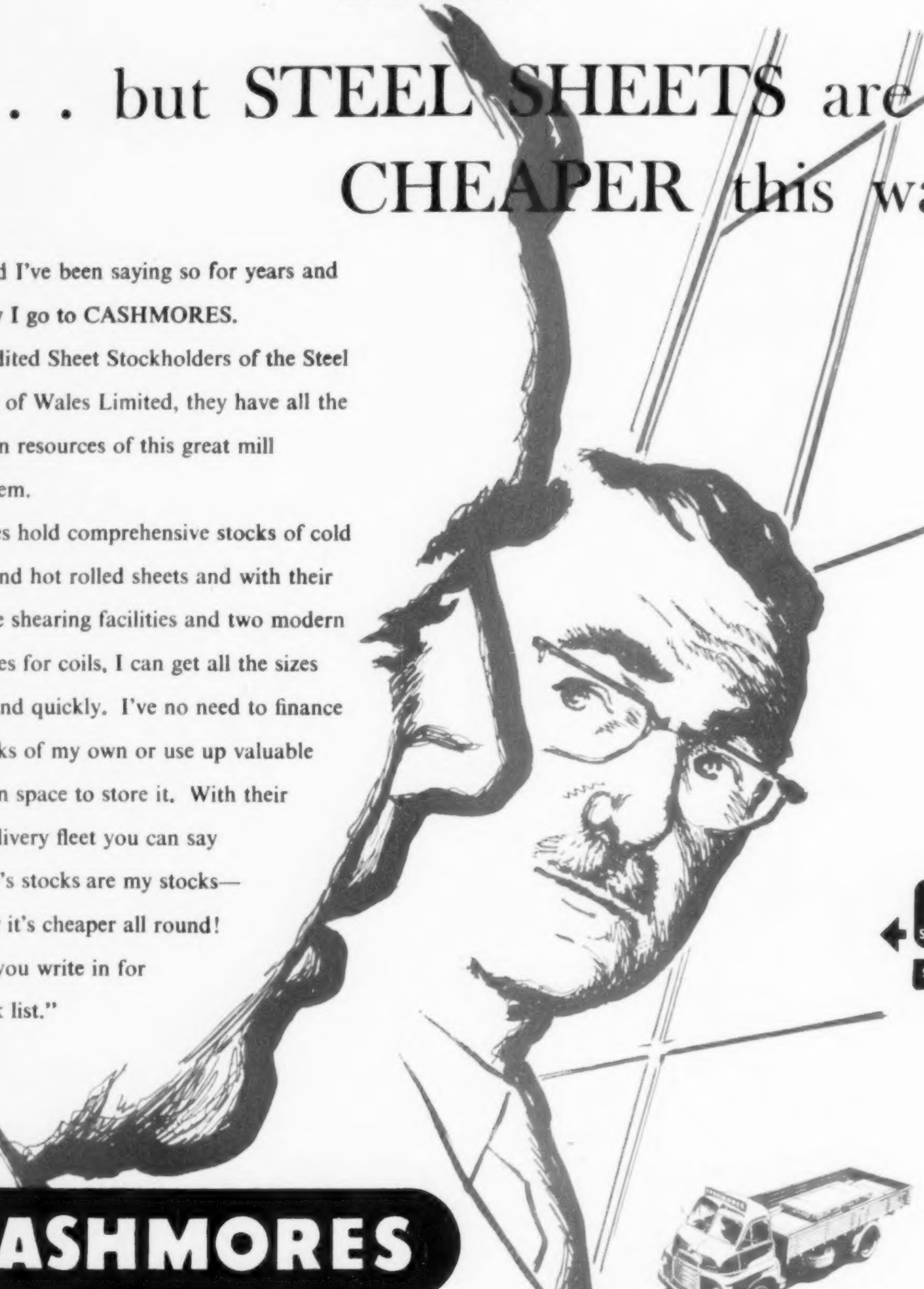
HOFFMANN SINGLE ROW SELF-ALIGNING ROLLER JOURNALS
are made in the following series:-
IN INCH SIZES – LIGHT AND MEDIUM
WITH TAPER CLAMPING SLEEVE AND NUT OR WITH PARALLEL BORE

HOFFMANN

Manufacturers of precision ball and roller bearings—established 1898

THE HOFFMANN MANUFACTURING CO. LTD. (P.O. BOX 7), CHELMSFORD, ESSEX

TELEPHONE: 3151 TELEX No. 1951



LONDON SHOW REVIEW